



Orbit

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The Journal of the Radio Amateur Space Program



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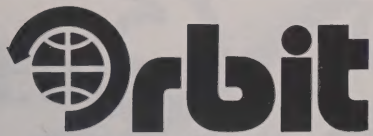
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Our Cover: Ulrich Mueller, DK4VW, and Wilfred Gladish laying out the x10 artwork for
the Mode-L transponder front end.

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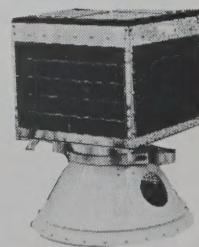
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Ellipsis...

AN EDITORIAL BY VERN RIPORELLA, WA2LQQ*

With this issue, *ORBIT* turns a corner. For the first time in seven years, AMSAT's flagship publication is not under the skilled hand of Joe Kasser, G3ZCZ. Joe's broad view of the hobby and his clear exposition attracted many readers. But now he's off to live with his family in Israel and though distance is often conquered in other areas of Amateur Radio, being Editor of *ORBIT* by remote control from the Middle East was not possible. Thus, it is with this issue your new Editor steps forward smartly to fill, if and where possible, the void resulting from Joe's departure.

Will *ORBIT* be changing? Yes, *ORBIT* will continue to evolve in subtle ways after Joe's departure just as it did during his tenure. However, there will be no radical changes from the directions established in recent time. Rather, changes will be in the form of refinements in emphasis, tone and perspective. Content, style and format will be largely unaffected. In fact, except for those who might happen upon the masthead, I suspect few will note any change whatsoever immediately. And that's probably for the best. Nature frowns on radical change. Readers probably do likewise.

My goals for *ORBIT* are quite simply stated. (Would that they were equally simple to implement!) When I am in Joe's present position of having recently completed my tour on the "bridge", I would like to be able to look back and see clearly that *ORBIT* had become a friend and companion to thousands of amateur satellite folks.

And, as a good friend, *ORBIT* had often been immensely helpful in solving problems, big and little. He had always been informative and occasionally entertaining and witty. There were one or two frivolous moments and a mistake or two. But one had to strain to recall them precisely. Above all, the impression one would have upon recalling this good friend is that he had been a consistent companion and a vehicle for broadening one's viewpoint by meeting new friends through him and by experiencing new vistas through his eyes. In character, our friend could fairly be called sincere and candid; flexible, versatile and accommodating yet having firm roots with a clear value structure not too unlike one's own.

If *ORBIT* becomes this good friend and I am thus able to view my tenure when it is my turn to step down as Editor, I will take as much pride then as I'm certain Joe takes with him now.

In order to better learn what members really want in their magazine, we have been discussing with some of you ideas which have been suggested occasionally. For example, a number have suggested classified ads in *ORBIT* would help the newcomer by providing a marketplace in which he might find suitable used, OSCAR-compatible equipment. Others have suggested Product Reviews as a guide to the array available on the new equipment market. Still others, have opined in favor of digital communications materials; perhaps a regular column on it.

One theme which has been noticed in this dialogue is the sense of constriction about the irregular publication date of *ORBIT*. A vocal few have taken the previous editor to task on the issue of regularity (see the letters column this month). We must say, however, that one obtains a different perspective on this issue sitting on this side of the Editor's desk. The fundamental truth of the matter is plain to see. *ORBIT* is written, edited and produced by volunteers. These are particularly dedicated individuals who volunteer their time so that *you* can get more fun out of hamming. Thus, it strikes one as particularly poor form to run about bemoaning the tardiness of the magazine. In fact, those who do the most moaning are notably absent from the staff of volunteers. We don't propose that volunteer status is a license to criticize and conversely, without volunteer credentials one must "stifle." However, does it not strike the reader as ironic that those who contribute the least are often the most vocal critics? A simple back-of-the-envelope calculation shows that 5% of the members do 95% of the work in the member services function.

Is there anything you can do to help produce the services demanded? Certainly! You can write an article. Or you might have a helpful "hint" that would be of interest to others. You could report on an interesting event for another example. Primarily though, you could be prepared to pitch in when and where requested. And you could come to view AMSAT as a self-help, volunteer organization of which you are a vital part rather than an exotic, quasi-official branch of government, for example.

Without some changes along these lines, AMSAT will experience its own version of "inflation" with more and more "consumers" chasing fewer products and services. We plainly need more producers of services and a more mature understanding of what makes this organization tick. Above all, we need to dismiss the notion of consumerism which is so inappropriate in the self-help, AMSAT context.

The UoSAT Magnetometer

By Mario Acuna,* LU9HBG/W3

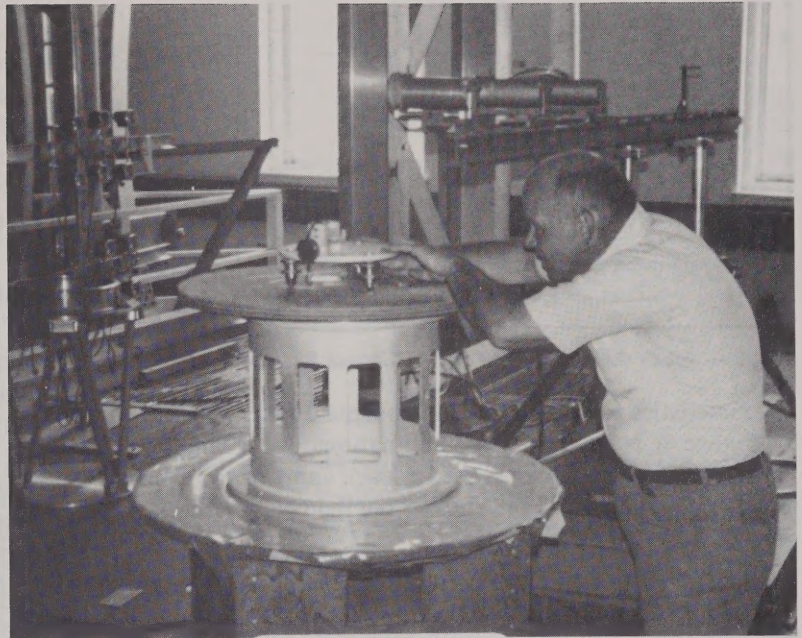
A detailed understanding of the earth's magnetic field is of fundamental importance in fields such as navigation, guidance, crustal resources exploration and radio propagation studies. The geomagnetic field is generally assumed to be constant and as being generated by a giant dynamo imbedded in the earth with its "coil" axis tilted about 11° with respect to the rotational axis and located slightly away from the earth's center. To a large degree this simplified concept is accurate but it is known that the field is not steady and significant disturbances take place due to complex systems of currents flowing in the ionosphere and magnetosphere which surround the earth. These disturbances, called "geomagnetic storms" can induce large currents at high latitudes in power transmission lines, telephone circuits and even the Alaskan pipeline where enhanced corrosion effects are observed due to the currents flowing in the pipe (of the order of 100 - 1000 Amperes).

The source of these disturbances lies in the complex interaction between the solar wind and the earth's magnetic field which creates currents that flow in the ionosphere and along magnetic field lines in the auroral regions. These currents can reach values of thousands of amperes although the current density itself is very small. The characteristic time of these disturbances varies from seconds to the period of the solar cycle (11 years) and major magnetic storms occur every few years. Minor "substorms" occur every few weeks. The magnetometer experiment aboard UoSAT, in addition to providing an effective medium to illustrate and measure the effects of these gigantic currents upon the geomagnetic field, will provide data which can help us understand how solar wind disturbances couple with the magnetosphere. The coupling gives rise to magnetic storms and associated high frequency propagation effects with which radio amateurs are quite familiar. Since these effects are par-

ticularly strong over the auroral regions, special emphasis will be placed on the acquisition of real time and memory data over the poles. Additional contributions will be made to the study and mapping of the main geomagnetic field although, due to limited knowledge of absolute spacecraft attitude, position and sensor orientation, these data will tend to be more difficult to analyze. Efforts will be made to correlate the data acquired with that obtained from MAGSAT since the UoSAT magnetometer resolution is nearly half that of MAGSAT. The MAGSAT spacecraft was launched in October 1979 to obtain the most accurate magnetic field data to date in both magnitude and orientation. It re-entered the atmosphere in June of 1980 after successfully completing its mission.

If successful, UoSAT data analysis could yield additional information on the secular variation of the geomagnetic field and the rate of decay of the dipole term, which, if the present trend continues, will decay to zero and reverse polarity in approximately 1200 years. Additional correlative studies with spacecraft such as DE and ISEE will be carried whenever possible. DE refers to the twin Dynamic Explorer spacecraft to be launched in July of 1981 to study the coupling between the solar wind, ionosphere and magnetosphere. ISEE stands for International Sun-Earth Explorers; a complex of three spacecraft launched in 1977 to study solar-terrestrial coupling effects. The completeness of coverage, data acquisition and reduction will be the determining factors in making these important scientific studies possible. The UoSAT magnetometer will allow the detection and monitoring of geomagnetic storms and their possible effects on radio propagation thus providing amateurs with advanced diagnostic and study capabilities.

A NASA Technician aligns the UoSAT Magnetometer head in the Mag. Test Facility. A Laser beam is visible on the alignment mirror.

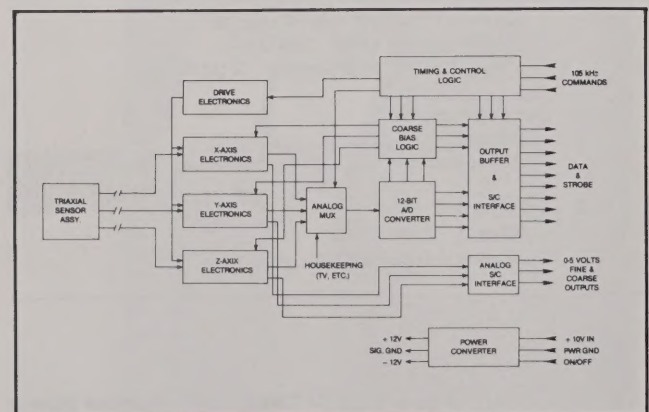


Instrumentation

A block diagram of the 3-axis magnetometer is shown in Figure 1. The heart of the instrument is a ± 8000 nT* ($1.0 \text{ nT} = 10^{-5} \text{ Gauss}$) fluxgate magnetometer whose outputs are digitized by a 12-bit, successive approximation A/D converter. The strength of the geomagnetic field is approximately 30,000 nT at the equator and 60,000 nT at the poles. Thus, this basic range of 8000 nT must be extended to 64,000 nT. The schematic diagram for the basic fluxgate magnetometer is shown in Figure 2. A 105.6 kHz clock from the spacecraft is divided by 8 to 13.2 kHz and the signal is used as the excitation source for the fluxgate sensors. These sensors are constructed with 3 orthogonally mounted, 1.2 cm diameter, 4.79 Mo Permalloy tape cores around which a diametrically wound flat coil has been located (see Figure 3). The 13.2 kHz signal is used to drive the cores to saturation with a non-linear resonant system. The presence of an external field causes a signal at the second harmonic of the excitation frequency to appear at the terminals of the diametrically wound coil. This can be intuitively understood if we consider that the voltage induced in the sense coil is always zero unless there is an unbalance in the halves of the toroidal core. This unbalance is introduced by the presence of the external magnetic field. The second harmonic signal amplitude is proportional to the magnitude of the external field component parallel to the coil axis. Its phase, with respect to the excitation signal (0° or 180°), depends on the direction of the external field. Thus the fluxgate sensor is analogous to an AC Wheatstone bridge except that its output is at the second harmonic of the excitation frequency. This signal is amplified and applied to a synchronous detector and an operational integrator whose output is used to drive a voltage controlled current source or transconductance amplifier. The output cur-

rent is applied to the sensor so as to cancel the applied field. Thus a measure of the current required to cancel the external field, as given by E_{out} , is a measure of the magnitude and direction of the field itself (parallel to the coil axis). The scale factor from gauss to volts is then given by the characteristics of the sense coil and the transconductance amplifier or voltage controlled current source. Additionally, the latter has a summing input into which we can add positive or negative signals which will result in the outputs being biased at a particular level. In this case, the dynamic range of the magnetometer remains at ± 8000 nT to $\pm 64,000$ nT. Three 4-bit digital-to-analog converters (one for each axis) are used to generate 16 bias steps of 8000 nT each. The digital input to the D/A converters is derived from an up-down converter which is allowed to count up, down or remains in a given state depending on the value of the 12-bit digital output of the A/D converter. This mode of operation results in the composite response

Fig. 1 — UoSAT: Vector Magnetometer Block Diagram



*nT = nano Tesla; a unit of magnetic flux

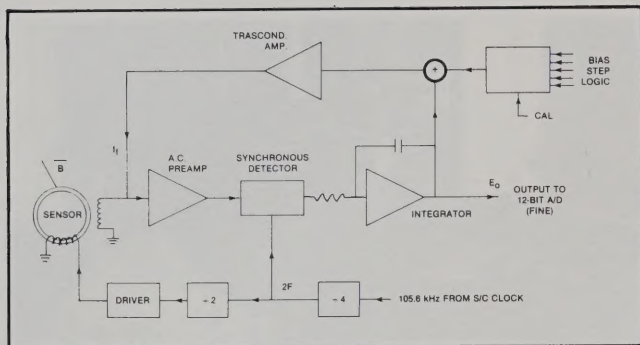


Fig. 2 — Block diagram of the UoSAT Sensor System.

characteristics for each axis of the magnetometer shown in Figure 4. Note that two combinations of “coarse” and “fine” counts are possible for each value of the external field, depending on whether the field was increasing or decreasing at the time.

The 16 resulting bits are placed in a tri-state elastic buffer and then placed into two bytes for loading onto the data bus. Each time a vector sample is placed in the buffer, the instrument signals the microprocessor that data is ready for collection with a data strobe signal. At the 1200 bps spacecraft bit rate, the effective sampling rate for the instrument is 6.25 vectors per second. A data and strobe timing diagram is shown in Figure 5. Housekeeping data (temperature and voltages) are multiplexed into the first and second bytes of a measurement sequence along with a sync bit to allow decoding by ground stations. Table I summarizes the principal characteristics of the magnetometer. The power con-

Table I — Vector Magnetometer summary of technical characteristics.

1. Basic Fluxgate Magnetometer

Dynamic range: ± 8000 nT

Resolution (12-Bit A/D): ± 2 nT

Noise (3.13 Hz BW): 1 nT

Zero level stability:

Sensor (-60°C to $+60^\circ\text{C}$): ± 5 nT

Electronics (-20°C to $+50^\circ\text{C}$): ± 2 nT

Drive Frequency: 13.2 kHz

Linearity error: 2×10^{-5}

2. Bias Field Generator

Dynamic Range: $\pm 64,000$ nT

Quantization step: 8000 nT

Temperature coefficient: 2 ppm/ $^\circ\text{C}$

3. Sensor Assembly

Mass: 120 gm

Dimensions: $7.5 \times 4 \times 4$ cm

4. Electronics

Mass: 1 kg

Power consumption: 500mW

verter accepts +10 volts from the spacecraft and converts them to +2 and -12 volts for use in the magnetometer.

In addition to the digital interface, an analog interface (0-5) is provided for the telemetry encoder. In this case, the “coarse” and “fine” signals are digitized to 10 bit resolution by the spacecraft and the magnetometer maximum resolution is then reduced to ± 8 nT.

Calibration and Alignment

The magnetometer was calibrated utilizing a triaxial Helmholtz coil system which is used to a) Null the earth's magnetic field and b) superimpose known, accurate fields along three orthogonal directions represented by the axes of the coils. The magnetic fields generated by the coils are calibrated with respect to a proton precession magnetometer which is used as a standard. In addition to determining the “fine” and “coarse” calibration constants, the angular alignment of each sensor with respect to a reference coordinate system was determined. Since the sensors are not mounted perfectly orthogonal with respect to each other, it is necessary to introduce a small correction to the raw data in the form of a matrix multiplication

$$\mathbf{B}_{\text{orth}} = \{\mathbf{M}\} \mathbf{B}_{\text{meas}}$$

where $\mathbf{B}_{\text{orth}}$ is the measured field $\mathbf{B}_{\text{meas}}$ corrected to an orthogonal reference frame by the alignment matrix $\{\mathbf{M}\}$.

Since the deviations from orthogonality in the sensors are generally less than 1° , the quick-look data represented by $\mathbf{B}_{\text{meas}}$ can be used without the correction for coarse attitude measurements and similar applications where knowledge of the field orientation with 1° accuracy is sufficient. When more accurate measurements are required and the magnitude of the magnetic field vector must be known to the limit of absolute accuracy of the instrument, the orthogonality correction should be applied. The values of the elements m_{ij} of the alignment matrix $\{\mathbf{M}\}$ are given in Table II.

The measured magnetic field values for each component can be obtained from the corresponding “coarse” and “fine” counts telemetered to ground as follows:

$$B_i = (\sum_j A_{ij} C_{Bj}) - A_{oi} - K_{fi}(FC_i - Z_i)$$

$$i = x, y, z$$

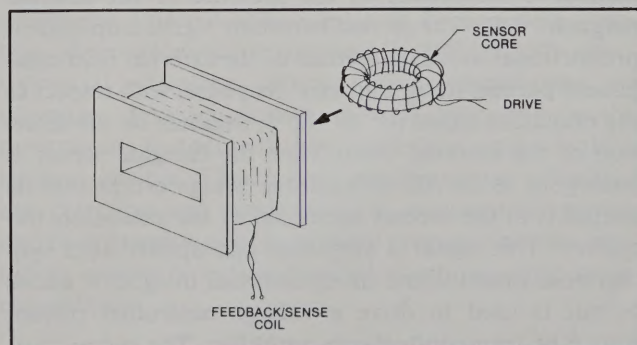


Fig. 3 — UoSAT Ring-Core Fluxgate Sensor

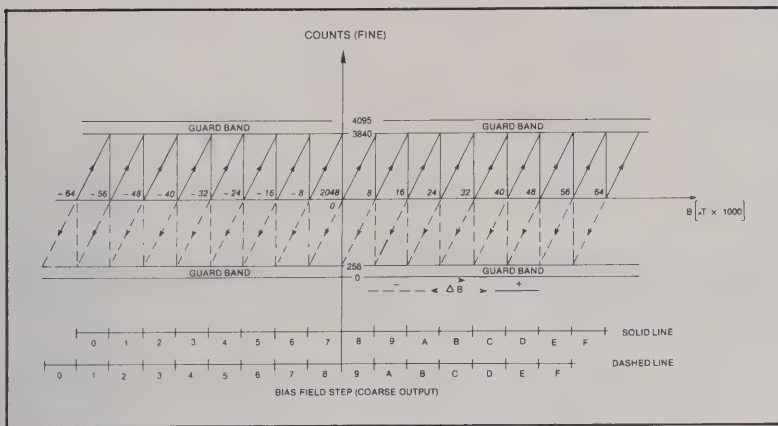


Fig. 4 — UoSAT: Vector Magnetometer Composite Response

where CB_j denotes the coarse bit values (0 or 1) for $j = 1, 2, 3, 4$ and A_{ij} represents the “weighting coefficients” given in the table for the i_{th} axis and j_{th} coarse bit. A_{oi} is a constant coefficient for each axis, while K_{fi} denotes the “fine” scale factor for the fine counts associated with the i_{th} axis, FC_i . The zero field count is denoted by Z_i . The following example clarifies the use of the above expression. Assume that we are reading the X-axis and it shows a coarse reading of F (hex) or 1101 (binary) and a fine reading of 2856 counts. Looking at the values for the coefficients in the table we have:

$$B_x = (1 \times 64822) + (1 \times 32411) + (0 \times 16213) + (1 \times 8131.1) - 64824 \\ - 4.478627(2856 - 2054) = 36,948.2 \text{ nT}$$

The same formula applies for the analog outputs from the experiment. The coarse analog output voltages corresponding to the 16 discrete steps in each axis are given in Table III. Also given in the table are the constants for the fine analog outputs which are digitized by the spacecraft. The calibration presented assumes an ideal 10-bit A/D converter since the final calibration is not known.

Table II — Calibration constants.

Coeff.	X	Y	Z
A_0	64824	64433	64072
$A_1(\text{MSB})$	64822	64432	64072
A_2	32411	32220	32039
A_3	16213	16114	16022
$A_4(\text{LSB})$	8131.1	8062.5	8011.4
K_f	4.478627	4.4825	4.43368
Z	2054	2051.2	2042

Alignment Matrix

$(M) =$	1000	0.008685	-0.014653
	0.001201	1.000	0.000398
	-0.00090	-0.0151134	1.000

The instrument fine calibration can be checked by means of the “calibration” command which injects an accurately known current into each sensor corresponding to approximately 900 counts (see Table III). In addition, two temperature monitoring circuits are included and their outputs are digitized by the experiment 12-bit A/D converter. To obtain the temperature readings from the appropriate housekeeping multiplexer data, the following expression must be used:

$$T (^{\circ}\text{C}) = K_T (TC - 2048) + b$$

where TC denotes the reading in digital counts and K_T and b are constants given in Table III. The power converter output voltages of +12 volts and -12 volts are also monitored through the experiment A/D converter and these values can be derived from the corresponding digital counts as:

$$V = 7.324 \times 10^{-3} (\text{Reading} - 2048)$$

Jan King, W3GEY standing next to the Braunbek Coils at the Mag. Test Facility.



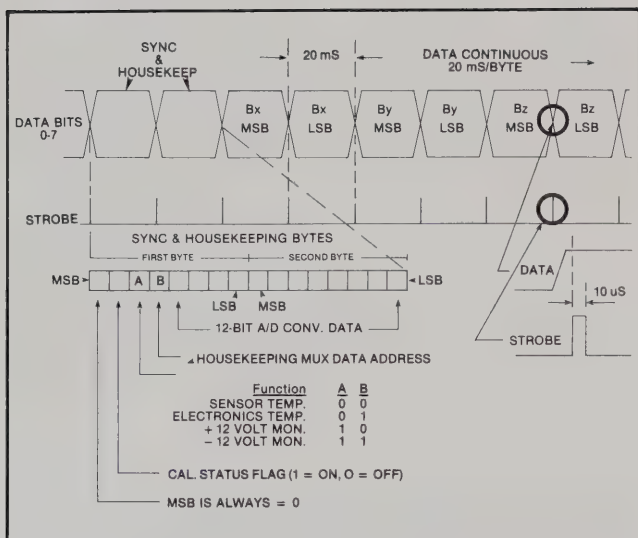


Fig. 5 — UoSAT: Vector Magnetometer Timing Diagram.

The outputs from the magnetometer are bandwidth-limited by a 3.13 Hz low-pass filter which is included to minimize aliasing errors since the maximum sampling rate is 6.25 samples/sec. When analyzing high frequency magnetic field fluctuations, the dynamic response characteristics of the instrument must be taken into account. This is easily accomplished since the overall transfer function is accurately represented by that of a single pole low-pass filter with a cutoff frequency of 3.13 Hz:

$$A(f) = 1/(1 + j\omega\tau_1)$$

with $\tau_1 = 5.08 \times 10^{-2}$ sec.

Acknowledgements

The development, implementation and calibration of the UoSAT magnetometer would not have been possible without the contributions of Andy Deskur, KA1M, John Scheifele, Everett Worley and Clell Scarce to whom the author is deeply indebted. The assistance of Jan King, W3GEY, and Gordon Hardman, ZS1FE, was essential to the successful completion of this project and is hereby acknowledged.

Dr. Mario Acuna, LU9HBG/W3 shown here adjusting the Laser used to align the UoSAT Magnetometer at the Mag. Test Facility.

Table III — Analog calibration constants*

Coarse step	X	Y	Z
F	971	973	967
E	905	907	901
D	840	842	836
C	775	776	771
B	710	712	706
A	644	645	641
9	579	580	575
8	513	514	510
7	448	449	445
6	383	383	380
5	317	317	315
4	252	252	249
3	187	186	184
2	121	121	119
1	56	55	54
0	0	0	0
K_f	18.05107	17.97	17.7593
Z	511	510	510

Temperature circuit constants

	T_1 (sensor)	T_2 (electronics)
K_T	4.0209×10^{-2}	4.0209×10^{-2}
b	+ 9.82	- 5.9

Fine calibration command

	X	Y	Z
counts	+ 908	+ 902	+ 904

*Assumes ideal 0-5 volts, 10-bit, A/D converter.



Mission Planning

(Phase IIIB Orbit Alternatives)

By Tom Clark,* W3IWI and Vern Riportella,** WA2LQQ

Building a satellite is one matter. Determining how best to employ this resource in serving the user community is quite another! Sifting through the alternatives involves considering a wide range of option suites. In fact, Mission Planning can be among the most complex engineering tasks. Understandably, the user community tacitly assumes that when engineering is involved, it is aimed at designing and building the transponder, the beacon, the solar panels and so forth; in other words, the *hardware*. Others would submit that designing the software was an engineering task. But is Mission Planning engineering?

When all the options are assembled, the result is an assortment of mission profiles of staggering proportions. Thus, determining exactly how the mission shall be flown can often best be accomplished using some rather arcane mathematics (linear programming) and the methods of the science of operations research and systems *engineering*.

The authors thought it instructive to cite a concrete example of how working with just a few variables can yield a number of widely differing results of considerable interest to the user community. The illustration chosen as a vehicle seems particularly poignant now in view of the concern expressed by a few of our astute colleagues. Briefly, these concerns centered on how the Phase IIIB elliptical orbit would be seen from their respective QTHs. In this treatment we will not attempt to solve any problems nor even to address all the factors. Rather, we hope to instill in the reader a better intuitive notion of three points:

- 1) Mission planning is a non-trivial exercise.
- 2) There are real constraints on what can be accomplished.
- 3) Perceptions of fine-detail objectives may differ.

In order to set the stage for discussion of Phase IIIB orbit coming next year, let us review what was planned for Phase IIIA.

Phase IIIA was to have been carried to a "geosynchronous transfer ellipse" by an Ariane launch vehicle. Also called a "parking orbit", the transfer ellipse serves as a way-station on the "way" to more useful orbits. Thus, Ariane was to have placed Phase IIIA in a parking orbit; then it would have been incumbent upon us to move where we felt we should in order to accomplish our mission objectives. Since the perigee of the parking orbit was to have been quite low (about 200 km; 124 miles), there would have been a strong incentive to "move on" *soon*. Satellites with low orbits tend to fall out of the sky with disturbing regularity; a subterranean perigee is NOT what we had in mind!

To move to a more useful orbit, Phase IIIA would have employed a small, solid-fuel rocket or, so-called, "kick-motor." The function of the kick-motor was to accelerate the spacecraft with a precisely timed maneuver. With good planning and successful execution, a new orbit would have been obtained that was both long-lived and provided an extraordinary communications potential for the world's Amateurs.

The amount of acceleration afforded Phase IIIA would have depended on two factors: a) the mass of the spacecraft itself and b) the force exerted by the kick-motor. These factors combined on Phase IIIA to provide the potential to attain a useful orbit with apogee at 36,000 km (22,000 miles) and perigee at 1,500 km (930 miles).

But, as is well-known, the usefulness of an orbit depends on more than just altitude.

With elliptical orbits, such as that planned for Phase III, there are two angles describing the relation of the

orbit to the Earth which are important. Since these angles are critical to our subsequent discussion we will take a couple of sentences to describe these angles.¹

The first angle is called inclination: i . Inclination is well-known to users of the Phase II (circular orbit) satellites. It is simply the angle, measured counter-clockwise, from the equatorial plane to the orbital plane. The second angle is called "argument of perigee:" $\omega\theta$. Though $\omega\theta$ does not play a part in circular orbits, it is most important to mission planning for elliptical orbits in Phase III. However, since this angle is difficult to visualize and next to impossible to describe in plain English, let us focus on the effect of $\omega\theta$ rather than trying to describe it rigorously.

The importance of inclination, i , and argument of perigee, $\omega\theta$, to Phase III mission planning is that together these two angles determine coverage of the satellite. Specifically, the two angles together determine the latitude at which apogee occurs.² (The longitude will vary constantly.) It is desirable to have apogee, the highest altitude of a satellite, occur directly overhead if one is interested in communicating with the greatest area, i.e., the best DX scope. Thus, for optimum DX scope, the sub-satellite point (SSP³) should be your QTH when the satellite is at apogee. The further away from your QTH apogee SSP occurs, the less is the surface area (DX scope) that you can cover. On the other hand, when apogee SSP is maximally distant, you will experience the greatest DX range. That is, when the satellite at apogee just "peeks" at you from your horizon, the satellite will be in view also of stations at the maximum potential communications range. The situation is analagous to maximum range considerations using Phase II satellites except, since the Phase II apogee and perigee are equal⁴, i.e., the orbit is circular, you experience maximum range potential *anytime* the Phase II satellites are on your horizon.

Therefore, it is considered important by many potential Phase III users to have apogee SSP, if not overhead, at least close at hand relatively speaking (on a global scale). We conclude that control of those two angles, i and $\omega\theta$ is important in determining the coverage (illumination) of the satellite. In other words, the usefulness of the Phase IIIB satellite for any given area is governed by these angles. What sets these angles? The kick-motor firing.

With Phase IIIA, the kick-motor had enough energy to raise the inclination from 17° , provided by Ariane in the parking orbit, to about 56° . Additionally, by precisely timing the motor firing and pre-orienting the

bird exactly, $\omega\theta$ would have been set at about 190° . But wait. The story gets more complex just about here.

As a result of the interrelation of our two angles with the rotation of the Earth, when the inclination is 56° , the argument of perigee does not stay fixed! The orbital plane actually precesses much as a spinning top with the result that $\omega\theta$ varies. And the variability of $\omega\theta$ has marked effects on the user community since it changes at the rate of a few degrees per month. Let us focus now on those effects.

As might be deduced from the foregoing, a result of constantly varying $\omega\theta$ is the latitude of apogee constantly changes at a rate of a few degrees per month. With Phase III, the apogee latitude would have varied from 56°N to 56°S over a period of about four years. Thus, for a while, each ham in the world would have been at just "the right latitude" to enjoy maximum DX (whatever that is!). That arrangement seems equitable enough; kind of spreads the "wealth" around!

But there *are* some negative aspects of this constantly changing DX scenario. Specifically, another result of the changing $\omega\theta$ heavily impacts the user community in its ability to accurately track the satellite over long periods (months). With manual tracking devices for Phase III (analagous to Phase II OSCARLocator; Satellabe, etc.) the transparent overlays would have to be replaced much too often. To allow reasonable tracking accuracy required by highly directional antenna arrays, the overlays would have to be replaced approximately every four to six weeks. Those with computerized tracking systems naturally would not be bothered by the changing $\omega\theta$ problem; those without computers, on the other hand, would likely find the requirement for continually changing the overlay a royal nuisance!

Fortunately, there is an escape from the dilemma. The solution is a special case of elliptical orbits called Molniya. The Molniya orbit, widely used by the USSR for communications satellites (including the US-USSR "Hot-Line") is distinguished by the fact that $\omega\theta$ does not change at all! Why this should occur is evident by inspecting part of the equation relating rate of change of argument of perigee, $\dot{\omega\theta}$, to i .

$$\text{Specifically: } \dot{\omega\theta} = k \cdot [2.5(\cos^2 i) - .5]$$

where k is a proportionality constant.

Setting $\dot{\omega\theta}$ to 0, we easily find $i = 63.43^\circ$. That is, if the inclination of the orbit is 63° , in round numbers, the rate of change of $\omega\theta$ is zero, i.e., $\omega\theta$ stays fixed. And, if $\omega\theta$ stays fixed, then the bother of constantly changing overlays is eliminated. It would be nice if that were the end of the story. But, as we have come to learn, for every benefit afforded, a price is exacted. We shall come to see what price must be paid for the "overlay salvation" shortly.

At this point, however, one might ask what it takes to get from the parking orbit to a Molniya orbit. It simply takes more "kick." As it happened, AMSAT was already looking for a method of obtaining more kick for Phase IIIB. Although Phase IIIA could have been boosted from its 17° parking orbit to about a 56° final

¹A more detailed view can be obtained from W3IWI's BASIC Orbits article in *ORBIT* #6 and also in *AMSAT Satellite Report* #4, 6 Apr. 1981.

²Apogee latitude = $\arcsin(\sin i \cdot \sin \omega\theta)$

³SSP: That point on the Earth's surface lying on a line connecting the Earth's center with the satellite.

⁴Equal to a first approximation.

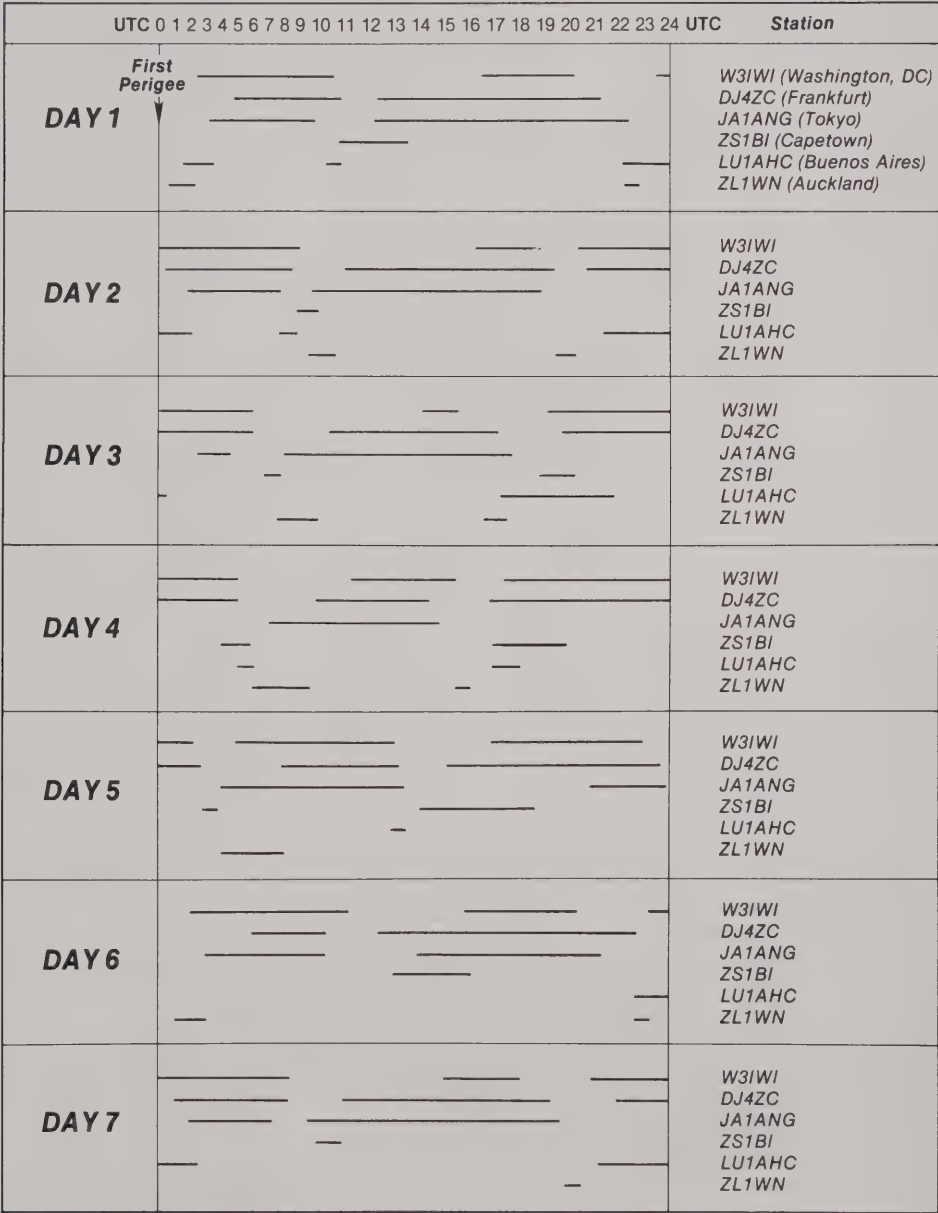
orbit, Phase IIIB was to be placed in a parking orbit having an inclination of only 7°. Thus, a substantial additional “kick” would be required to get Phase IIIB to even the 56° inclination that had been planned for Phase IIIA. Moreover, in the interim, it had become obvious to the designers and planners that the Phase IIIA 150 kHz Mode B transponder likely would have been overwhelmed with stations (QRM) after a couple years of operation. There was, therefore, the strong incentive to include on Phase IIIB a second transponder which would afford users the “wide open spaces” of an 800 kHz passband. Furthermore, advanced studies by AMSAT demonstrated a real need for upgrading the thickness of the radiation shielding which protects essential elements of the satellite (the ICs in particular). Thus, the desire to incorporate a second transponder for operational reasons and the need to improve shielding for survivability reasons coupled to drive the overall spacecraft mass higher for Phase IIIB. In sum, therefore, the fact we were to be deposited in a lower,

7°, parking orbit and the higher mass mandated for the reasons outlined above that we diligently seek more “kick.”

After some superb negotiating by our AMSAT DL colleagues under DJ4ZC, a leading German aerospace firm agreed to provide AMSAT with a liquid-fuel kick motor. The firm, MBB, had previously made small liquid-fuel engines for space. Furthermore they had an off-the-shelf model that seemed ideally suited for overcoming the problems with Phase IIIB having to do with more mass and lower parking orbit inclination.

The liquid-fuel kick motor potentially provides a number of significant benefits. First, liquid-fuel kick-motors inherently pack more energy per unit mass of fuel. That means that more “kick” will be available to accelerate the spacecraft with the same fuel mass. So, employing the MBB motor solves the spacecraft total mass and parking orbit inclination problems. It also allows us to reach that “magic” 63° Molniya slot! Second, the liquid-fuel motor would be restartable. Unlike

Fig. 1 — A week in the life of Phase IIIB. See text for details of the orbit. The data presented is a reasonable representation of what might be expected.



From To	Hours of Mutual Visibility					
	Washington	Frankfurt	Tokyo	Capetown	Buenos Aires	Auckland
Washington DC	105.5 63%	92	58.5	6.3	14.6	3.8
Frankfurt	92	119.5 71%	79.5	12.1	10.1	0
Tokyo	58.5	79.5	100.5 60%	4.0	0	9.3
Capetown	6.3	12.1	4.0	17.3 10.3%	2.0	0
Buenos Aires	14.6	10.1	0	2.0	21.3 12.7%	0.5
Auckland	3.8	0	9.3	0	0.5	14.1 8.4%
Washington and Frankfurt	92	92	51	5.5*	9.5	0
Tokyo and Frankfurt	51	79.5	79.5	3.6	0	0
Washington and Tokyo	58.5	51	58.5	0	0	0

*Includes 1.0 hours at both Buenos Aires and Capetown.
Percent shows fraction of time visible at this location.

Fig. 2 — Reformatted data from Fig. 1. See text for further details concerning the additional computation.

its solid-fuel cousin, the MBB motor could be fired in a series of ever-more-refined bursts to precisely shape the orbit.

In summary to this point, then, we have seen:

1) On Phase IIIA, spacecraft mass and available kick-motor energy would have limited us to a single transponder and a low (56°) inclination that would have required frequent support of those using basic manual tracking devices (locators). Moreover, a mass limitation would have allowed less radiation shielding with a consequent (perhaps significant) reduction in spacecraft expected operational life. On the positive side, the 56° inclination would have meant a constantly varying DX vista for Amateurs around the world. Any given QTH (between 56°N and 56°S) would be, at one time over a span of years, legitimately called an “unexcelled satellite DX QTH.”

2) With the MBB liquid-fuel kick-motor on Phase IIIB we can carry more equipment and shielding which means more utility for the users over a longer period. And, by attaining the Molniya orbit, tracking problems would be notably reduced.

End of story?

Not quite. This article is about difficult tradeoffs in mission planning and it is only now that we are at the point where we can perceive some of the core issues involved in these trades.

In return for ease of tracking afforded by Molniya we pay a price. The price exacted is DX scope. Since the argument of perigee stays fixed, once the angle is set at the time of kick-motor firing, that's it; you've got that angle essentially forever! And, since apogee latitude will stay fixed with unchanging ω the advantages of having apogee near one's latitude will be permanently allocated.

Finally, we are in a position to clearly define the problem. Given unequal amateur distribution on Earth's surface, how shall the argument of perigee be set so as to be “maximally useful” to the community?

One answer is fairly simple. And, as so many other simple answers, it is probably wrong! The simple solution would involve taking a census of amateurs including their latitudes. You would then determine the average latitude at which amateurs lived. Let's call this figure, “mean residence latitude.” Then, in the simple solution, one could set the argument of perigee so that the “mean residence latitude” was maximally illuminated. That is, the orbit would be positioned so as to favor the areas where most amateurs lived. A measure of comparison would use units of say, kiloham-hours per day illumination!

But is that what is meant by “maximally useful?” We think not. One is impelled to ask whether there is not a better definition than maximum illumination time. It is also necessary to ask what penalty is exacted from those remote from “mean residence latitude.” Since 90%+ of the world's hams live in the Northern Hemisphere, what will be the DX usefulness and general effectiveness to the Southern Hemisphere amateur of a Molniya orbit with apogee forever occurring very far North? Is there no room for a better definition of “maximally useful”; for compromise? We strongly believe there is and will spend the balance of this article developing one set of alternatives to the simple solution exemplified above.

Rather than address these crucial questions in generalities and abstraction, one of us (W3IWI) devised a variation of his general purpose satellite tracking program (see *ORBIT* #6) called “Mutual.” In this version, mutual visibility windows are identified and quantified. The analysis provides the basis for some “illuminating” comparisons. Please refer to the accompanying graphs and matrix.

Review first Figure 1, “A Week in the Life of Phase IIIB.” Note that Molniya is assumed ($i = 63^\circ$) and that argument of perigee is 240° . The intervals each of several representative stations is illuminated for a typical week is shown by the horizontal plots. These plots can be related to time of day by using the horizontal scale demarked in hours. One should keep in mind that long-term averages will differ from the weekly average since a week is not that long in terms of orbital periods (only 16 orbits). The sample should be, however, reasonably representative.

Figure 2 shows essentially the same data reformatted in matrix form with an additional computation included. On the matrix diagonal we see each station's illumination in terms of hours per week and fraction of time illuminated (in %). Within the other matrix cells we find the mutual visibility windows in terms of hours per week. The lowest three rows show three-way mutual visibility totals in terms of hours per week. For example, Tokyo and Frankfurt have a joint window with Capetown for 3.6 hours per week.

Figure 3 shows a plot of illumination time per week (in minutes) versus argument of perigee for a typical deep Southern Hemisphere QTH (Capetown). At the argument of perigee discussed in this article ($\omega = 240^\circ$), Capetown is illuminated more than 1000 minutes per week. Of that time, Phase IIIB would be at an altitude of greater than 5000 km for more than 80% of the time. Use the latter figure as a guide to coverage compared with AO-7 at 1500 km.

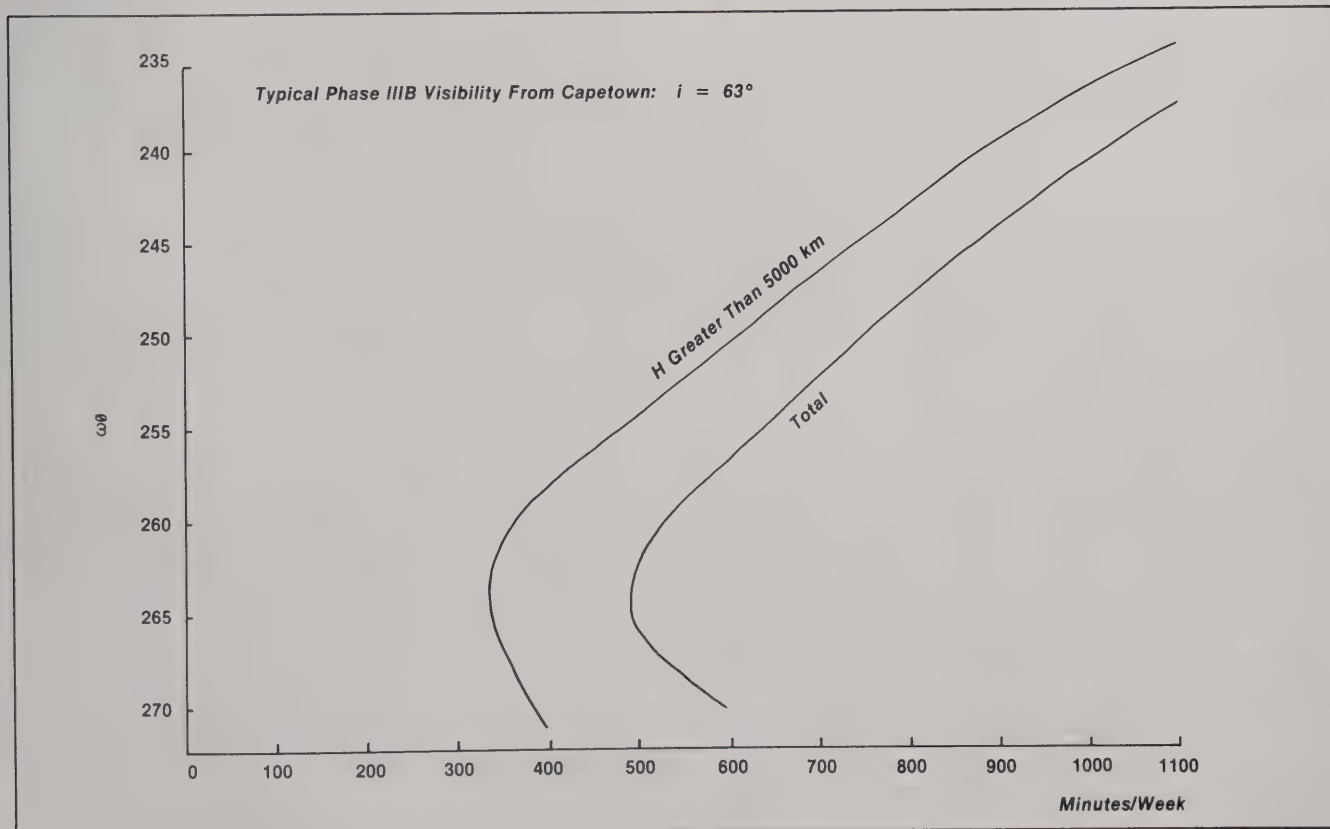
Utility of the Phase IIIB satellite with the assumed orbital parameters shows the Northern Hemisphere, which incorporates 90%+ of the world's amateurs, with an illumination advantage as might be expected. Yet as is plain from examining the figures, if ω is set at 240° (with the result that apogee occurs at 50°N), the coverage provided our Southern Hemisphere colleagues is much, much better than had been feared. Conversely (and significantly) Northern stations have increased visibility into the Southern Latitudes. However, here is the tradeoff. In order to realize the increased DX scope, Northern Hemisphere stations must yield a bit of illumination time. In other words, this tradeoff reduces to a matter of trading more DX countries for a small reduction in operating time. However, since the reduction in viewing time is small compared to total illumination time for the Northern Hemisphere, the trade seems at least entertainable. The South, for their part, would benefit considerably from such a compromise as seems clear from the data. Is this the end of the story? A happy compromise is found and all lived happily ever after? Not quite. Read on!

To this point we have addressed only the effects of various tradeoffs on the user community. Are there no spacecraft considerations that enter? Naturally there are; and major factors, too. Moreover, if there is a conflict between the user convenience and the spacecraft health, the spacecraft wins (automatically!).

In determining what ω is finally to be set, we are constrained by factors of solar illumination angle and the resultant effects on spacecraft thermal design and electric power. If the argument of perigee is set too much below 240° , we suspect that at certain times of the year the sun angle will be largely favoring the Z-axis ("top") of the spacecraft. At these times the delicate balance between heat absorbed/heat generated and that heat radiated into space will be severely upset. The thermal design, meticulously engineered by WD4FAB with a huge computer model, would thus go by the boards. The consequence could be fatal to Phase IIIB. Moreover, since the solar panels would be very poorly illuminated at these special times of the year, the electrical power would be severely curtailed. The result could be permanent damage or at least degradation to the batteries.

Though there are some possibilities of spacecraft attitude adjustment during these critical periods by using the torquing magnets which are used to orient and stabilize the spin, the question arises: Do we really want to enter this risk-laden domain of options when it is of questionable operational value to set ω much below 240° ?

Fig. 3 — Illumination time vs. argument of perigee for Capetown.



There is an expression we know in English that probably has its origin in the Middle East. We suspect this expression has equivalents in many tongues. It is: "For nothing you get nothing." This succinct expression of the realities of Mission Planning specifically and engineering in general has been implicit throughout our discussion.

Initially we saw how mass and kick-motor energy limitations constrained Phase IIIA to a potential 56° inclination. We learned how that inclination had its benefits and detriments. On the positive side, it yielded an enormous DX scope to virtually all the world's hams over a period of years. On the negative side, the 56° inclination would have made miserable the lot of a large number of potential users because of the inevitable need to replace locator overlays monthly.

Then we saw how the option of using the liquid-fuel kick motor to overcome the mass and energy constraints also allowed us to attain the Molniya, 63°, orbit. Molniya solved the locator overlay problem but gave us another in return: illumination. It required us to closely examine the value of argument of perigee since it remains essentially unchanged "forever." We thus learned of a strong incentive to "get it right the first time!" Molniya required us to evaluate DX vistas from many

latitudes and to seek better definitions of "maximum" and "optimum."

Finally, we have seen that even when reasonable trades can be identified between the diverse needs of a geographically dispersed community, all trades thus identified still must defer to spacecraft health and welfare considerations.

Is *this* the end of the story? Almost.

If we were satisfied we *really* knew what "maximally useful" meant, it would be the end. Does it mean greatest illumination time or DX variability? Is it a combination of the two? Or neither? Or what? Such is the dilemma of Mission Planners.

The inputs to the planners come from many and varied sources and include considerations of cost, schedule and technical matters. Overriding these at the policy level is organizational philosophy which admits a much broader scope. Perhaps your input to the planners as regards definition of "maximum," "optimum" will help understanding value systems, *vis a vis* amateur satellites. Knowing what *you* consider important will nominally reduce the complexity in what now probably impresses the reader as a fairly involved enterprise: Mission Planning.

AMSAT Software Exchange

(Part I: H.P. and T.I.)

By John Montague, WØRUE

Please Note:

Programs will be made available only to AMSAT members; be sure to include your member number (or completed membership application) to:

AMSAT Software Exchange

Box 541

Willenite, MN 55090

Administered by John Montague, WØRUE.

Purpose

To provide AMSAT Members easy access to software useful to satellite experimenters. Emphasis will be placed on programs for the HP-41C and TI 58/59 due to their capability to read machine readable media (bar codes, magnetic cards) and the availability of these machines for reproducing cards. Programs of particular merit written for other calculators or computers will be made available, however no facilities are available to provide machine readable forms (individual authors may offer to copy programs onto card, tape, disc, etc., in the program documentation package).

Submissions

All interested persons are invited to submit programs to the library. Good documentation practices are essential since nothing is worth less than a poorly or incompletely documented program. All documentation must be on one side only of 8½ x 11" pages and of a quality that yields good Xerox copies. The minimum acceptable documentation package is:

1. Abstract (50 words or less); include machine and configuration.
2. Program description, including a flowchart.
3. Program listing (preferably a good quality Xerox of printer listing—use yellow filter to get good copy of blue thermal paper) with notations where appropriate.
4. Listing of Register usage.
5. Sample Problem—inputs & outputs.
6. Recorded magnetic cards (if for HP-41C or TI 58/59), two sets preferred.

The various machine manufacturers sponsor program libraries. These libraries publish Program submission guidelines that are recommended to contributors. No program will be accepted unless accompanied by a statement over the authors full signature stating:

"All information provided with this submission is freely contributed to the AMSAT Program Library with no obligations or restrictions. I certify that I possess all authority to grant unrestricted

rights to these materials and that they do not infringe on the copyright or other rights of another.

Signature _____ Date _____
Printed/typed full name and address"

The library reserves the right to reject submissions that are incomplete or duplicate existing, cataloged items.

Obtaining Copies of Programs

A catalog of program abstracts will be made available for a #10 SASE. Summaries of the best new submissions will be printed in *ASR* and *ORBIT* as space permits. A contribution of 10¢ per page of documentation is requested to cover costs of reproduction (any excess will be submitted to AMSAT general fund). If magnetic cards are desired, submit the number of cards required for the program, as listed in catalog or article, plus one card to defray wear and tear on librarian's machine.

Next issue: Part II, TRS-80, Apple.

Mode J At Last!

By Frank Wiesenmeyer,* K9CIS

Editor's Introduction to K9CIS: More than any prior amateur satellite mode, J has required the hopeful operator to engineer his station. This requirement has fallen quite heavily on those whose primary interests are operational rather than technical. The tasks of assembling, testing and refining a J-compatible station have been frustrating experiences for many. In short, the transition from AO-7B to AO-8J has not been easy.

When using AO-7B, it was often possible to gloss over and ignore technical details or to overwhelm them with "brute force" solutions. However, on AO-8J these details play a critical role. Moreover, neglect of technical detail most often cannot be compensated for by application of either brute force or one-shot, band-aid solutions. Rather, a good J-station should be engineered literally from the ground up. And success depends critically on incremental improvements: a little better performance with each refinement. Half a dB there; .2 dB here; it all adds up!

Mode J has been a test for the technician in all of us. But it should be well-noted that as in the other modes, J solutions are not particularly mysterious or complex; there just happen to be many aspects. Thus derives the incremental approach.

A superb example of the incremental solution approach (one might call it successive approximation) first appeared in the *AMSAT Newsletter* in September, 1979. This now-famous article by Frank Wiesenmeyer, K9CIS, is reprinted below. Frank's watershed article is today as valid, timely and informative as it was when first run. His entire approach is based on the sophisticated notion that with Mode J, improvements come in little bunches and that there simply are no one-step, brute-force elixirs to success on J.

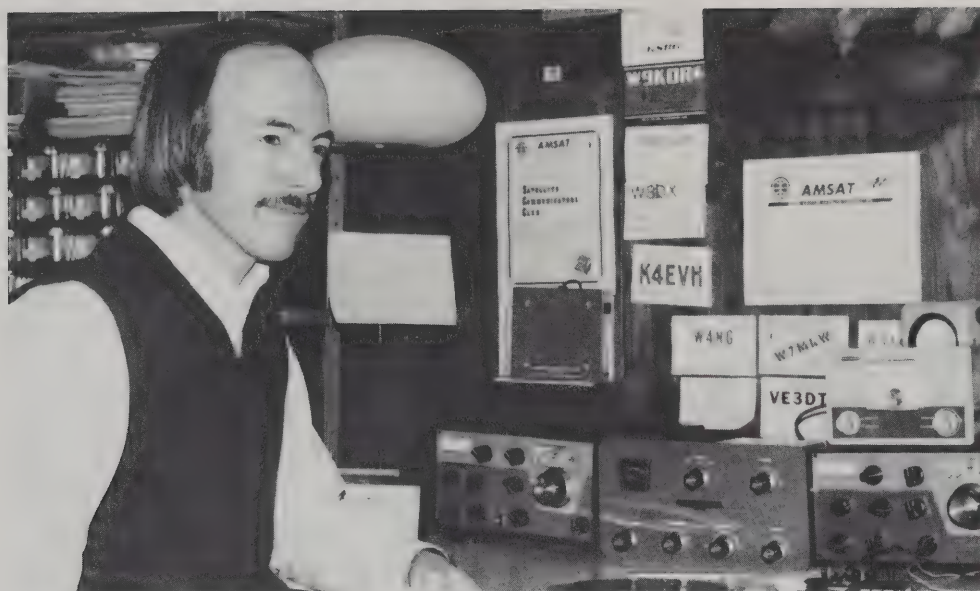
It is truly spoken that nothing in life is certain except death and taxes. After having reread the K9CIS article, though, one is tempted to add the K9CIS methodology to the list!

Many amateur satellite operators have found their initial attempts at using Mode J to be disappointing at best. Some have even experienced the ultimate failure of hearing nothing at all. Admittedly, the signals from AMSAT-OSCAR 8 Mode J are not strong, but they do exist, contrary to some erroneous rumors, and they can be heard loud and clear with the proper receiving equipment. In comparison with Mode A, there is almost no "man-made" interference, such as power line hash. Ionospheric related interference, such as QRM due to terrestrial communications, is almost non-existent. In short, Mode J is a superior mode for satellite com-

munications similar in many ways to AMSAT-OSCAR 7 Mode B. The purpose is to share with you some of the secrets of successful Mode J operation, so that you too can join in on the fun and excitement of AOS to LOS rag chews using this superb transponder.

Early Attempts and Failures

I started my satellite career with AMSAT-OSCAR 7 Mode B, and got spoiled right from the start. I had high standards of comparison set for AMSAT-OSCAR 8 Mode J and I must confess, my early attempts were a



K9CIS some years ago at his operating position.

disaster. But, read on! A few months later, disaster had changed into success.

About the time AMSAT-OSCAR 8 was successfully launched, I ordered my Hamtronics C432-5 70 cm uhf converter kit. I just could not stand the thought of a new satellite being in orbit and not being able to hear it. You will recall that AMSAT-OSCAR 8 started out in Mode J until it had stabilized sufficiently for deployment of the Mode A antenna. Just before launch, the experts were predicting that it would be about a week, or maybe longer, before the satellite stabilized and could be commanded into Mode A. That was too long for me to wait, so I called Hamtronics and ordered a converter kit over the telephone. They said that they could ship it right away, but that they were out of crystals! Well, the converter showed up on March the 9th and I had it built in one afternoon. Luckily, I found a crystal in my Heath HA-202 FM rig that would work in the converter until the factory sent the 45.222 MHz rock that converts 435.0 to 28.0 MHz. After going through the simple alignment procedure, I was able to hear a noisy 0.3 microvolt signal at 435.1 MHz on my R4C receiver with the HP8654A signal generator connected to the converter. This was encouraging and verified what Hamtronics claimed in their specifications. I calculated the first available "in range" orbit and listened with my uhf TV antenna, used for TV DX-ing, and heard absolutely nothing! AMSAT-OSCAR 8 was not in Mode A, as I did not hear anything on 10 meters either. I had been tracking AMSAT-OSCAR 7 successfully for months, and use of the Oscarlocator had become routine. However, just to be sure Murphy wasn't working overtime to foul up my first attempt to hear Mode J, I checked and rechecked the calculations, but found no error. Several more passes produced the same results. My uhf TV antenna, by the way, is a six-foot parabolic and it has a low noise broadband preamp mounted right at the antenna, which later proved to work reasonably well on relatively distant low-elevation angle passes.

The next attempts at hearing Mode J were made using the Cushcraft 432-20T, 20-element circularly polarized antennas used for Mode B operation at the college where I teach Electronics. The results were again the same; nothing, not even a faint trace of a cw signal or of the beacon. There was a reason however. By necessity, I had used about 150 feet of 8237 RG8 coax between the antennas and the shack at the college and the uhf loss (about seven dB) was eating the relatively weak Mode J signals alive! You must remember that I was still thinking in terms of AMSAT-OSCAR 7 Mode B, where the downlink was so strong that almost anything worked! When one considers the fact that we were only running eight watts output on 432 MHz when operating Mode B, it is quite a tribute to the sensitivity of the AMSAT-OSCAR 7 Mode B transponder that we worked out so well on Mode B with this obviously less than ideal 70 cm setup at the college. So much for failure!

First Taste of Success

Now let's get to the success part of the story. I called ARRL headquarters and told my sad story to Bernie, W9KDR/1. He said not to give up and that a lot of people were hearing Mode J well. Bernie confessed that the signals were not as strong as on Mode B, and that it was just a different ballgame listening at 435 MHz. He added that you need a low noise figure "front end" preferably, with the preamp mounted right at the antenna. That sounded familiar. Unfortunately, I had to wait a while to try Bernie's suggestions (moving the family residence across town).

My first success at hearing Mode J was more like a failure. But I did hear it when I got my Cushcraft 435-20T antenna up on the chimney (with only 30 feet of RG8 coax leading to the converter). I could not hear the 100 mW beacon, but I could barely make out the stronger cw stations in the passband near TCA on close passes.

Improvements Come a Few dB at a Time

With this very modest but important bit of success under my belt, I next ordered a Hamtronics P-15 435 MHz JFET preamp. Indoor tests, on the bench, showed that the addition of the 70 cm preamp noticeably improved the sensitivity of the converter. I could now hear -130 dBm (.07 microvolt) signals reasonably well. The major advantage of the preamp was that it could be remotely powered and conveniently mounted outdoors at the antenna. A quick check with the preamp indoors, produced my first Mode J telemetry. Signals were 339 to 449, nothing spectacular, but I was at least hearing the Beacon! Before the next orbit, I climbed up on the roof and mounted the preamp right at the antenna. For this first test a 9-V battery was used to power the preamp outdoors, but it didn't take long to discover the inconvenience of running outside and climbing to the roof to disconnect the battery! Worse yet, I left the battery on all night a couple of times and that started running up the cost. After a few days of this routine, I built a 12-volt remote power supply. I used a converted TV preamp power supply that I happened to have on hand, but the circuit could just as easily have been built in a Minibox. The results were quite impressive; dramatic in fact! Moving the preamp to the antenna, which only offset approximately a two to three dB loss in the 30 feet of coax cable made a big difference. This result reminded me of what Bernie had said, "Every dB of loss counts at 70 cm." It still wasn't Mode B, but I was hearing the beacon 569 on distant passes and 599 when the bird came in close. Best of all, there were no desense problems when the uplink was keyed. KØRZ was my first Mode J QSO. I was finally on Mode J and finding out where all my friends from Mode B had gone. However, the QSB was still somewhat of a problem and not every pass was the same. One thing you learn quickly after operating Mode J for a while is that the performance is sometimes inconsistent and unpredictable, with some passes producing better signals than others. The secret is to have sufficient fade margin so that you can afford some QSB.

The initial uplink was very simple: just an old Gonset Communicator IV, crystal controlled two-meter a-m rig, converted to cw and running 10 watts output to 30 feet of RG8 coax. The uplink antenna was an Az-El mounted Cushcraft 144-10T 10-element RH circular polarized antenna up 25 feet on a chimney and rear mounted beside the 432-20T 20-element 435 MHz antenna. For those not familiar with the 144-10T, it consists of two five-element gamma-matched Yagis mounted at right angles to each other on a single boom as shown in the photograph. The 90° delay line produces right- or left-hand circular polarization, depending on which antenna gets the delay line. I should mention that a problem was encountered elevating these antennas with the U-100 rotor as suggested by Cushcraft. I found that mechanically balancing the antennas, by moving the mounting point on the two-meter antenna toward the

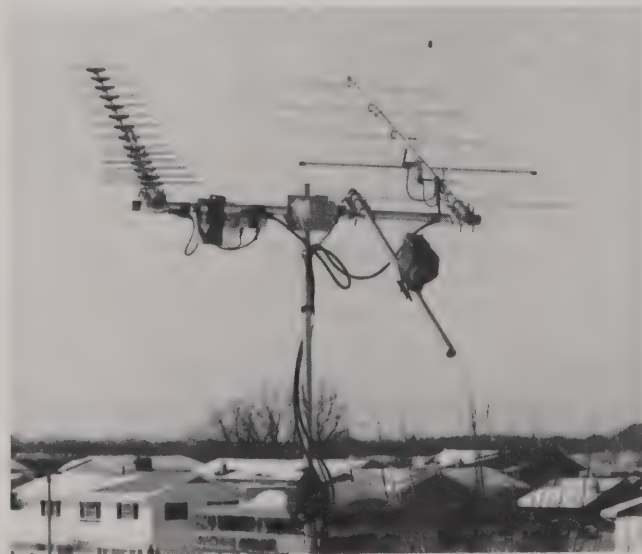
center of the boom was necessary. I did not like this arrangement, however, because the side stacking boom passed through the elements of the two meter antenna. It did work alright mechanically, but it seemed like Mode B signals faded more with the two-meter antenna mounted near the center of the boom. I had previously had the two meter antenna rear mounted, but at a fixed 30° elevation angle for Mode B operation.

One way to get a U-100 rotor to elevate the rear mounted antennas is shown in the photograph where an extra boom and counterweight (old rotor) have been added to balance the system mechanically. I have been using this system now for eight months with no problems. A rotor with more torque might be a good alternative, but this approach would no doubt require a new elevation rotor mounting bracket.

Approximately 145 enjoyable Mode J contacts were made with this 10-watt system when I added a Heath HA-202 40-watt PA for distant passes. I had tried using this type of PA earlier but it generated far too much static in the downlink to be useful. My brother's HA-202 was clean. The addition of the 40-W PA was of some help in maintaining a signal in the satellite on distant passes. One thing I did notice with the amplifier on was that when the satellite was very busy with a lot of strong signals in the passband, I did not find my signal abruptly changing level due to AGC action. On distant passes, without the PA I was accustomed to hearing my signal suddenly disappear or change signal strength abruptly when a strong signal somewhere else would enter the passband.

70 cm Antenna Improvements

At this point I still was not satisfied with Mode J, because I still did not hear it as well as the old Mode B. But, with AMSAT-OSCAR 7 ailing badly, there was nothing else to do but to try to improve the downlink some more on Mode J, with Mode B, as always, the



standard for comparison. I had tried improving the impedance match with simple adjustments to the gamma matches. For these tests, a Bird Model 43 wattmeter was set up on the roof, close to the antennas to get the most accurate VSWR readings. Unfortunately, no improvement could be obtained. Several months of experimenting with the 432-20T, plus on the air experience finally led me to believe that some improvement in the downlink might come from a different 435 MHz antenna. Improved bandwidth was a consideration in selecting the next antenna, and the KLM 420-470 seemed to be a good choice with its log periodic driver and sleeve balun. From a purely visual inspection of the KLM antenna, I was particularly impressed by their use of a type N connector on the balun. So, I bought a KLM Model 420-470 14 element Yagi, along with their balun and hurriedly installed it. The KLM 14-element hybrid LP-Yagi turned out to be a very good choice. However, I still did not see the dramatic improvement I was looking for. The pattern on the KLM antenna is exceptionally clean and the front to back ratio measured consistently greater than 20 dB across the band, even at TV Channel 15, indicating exceptionally wide bandwidth. The impedance match was excellent with a flat VSWR of 1.1 across the band 432-435 MHz. Overall, a small performance improvement was made, but not the big “breakthrough” I was looking for.

The Big Breakthrough

If you haven’t noticed the pattern yet, the challenge of Mode J is met a few dB at a time and every last dB counts! But the one big improvement I had been hoping for finally came. I decided that an ultra-low noise figure was the only thing left to try. If that didn’t produce significantly better results, I would have to give up and conclude that Mode J would never come close to Mode B performance with respect to downlink signal-to-noise ratio. I, therefore, ordered a Janel 432-PC preamp.

With a break in the weather coming along, I finally got a chance to get to the roof so I could install the Janel 432PC high-gain low-noise preamp. The same remote dc power supply described earlier was used. The new preamp was first checked out in the house with a HP8654A signal generator and it promptly showed its potential. Signals of -140 dBm (.022 microvolt) were easily copied with a good signal-to-noise ratio. This system was far superior to anything I had ever tested before. Off the air signals soon revealed what a low-noise-figure preamp mounted close to the receiving antenna can do to improve weak signal reception at 435 MHz. I heard the beacon on a distant 48.4° W, easterly pass like I had never heard it before. There was no doubt about the results of this change; it was fantastic! I tried a quick QSO with Dick, W8DX, but, “hold it” I had a new problem: desense. Keying the transmitter wiped out everything in the downlink! By now, I had heard enough to know I was going to find some way to use this bipolar preamp, no matter what kind of filter it

took. In a note from W9KDR, he explained that many Mode J users were using cavity type band-pass filters ahead of their receiving “front ends” to eliminate desense problems. I had more than a desense problem however; I could not hear a thing from AMSAT-OSCAR 8 when the transmitter was keyed. Obviously, a good low-insertion loss band-pass filter was needed and I just happened to have a Jerrold Model UMN-3 cavity type TV bandpass filter-mixer on hand, which I hoped would do the job. I realigned it to 435.1 MHz. The insertion loss measured only one dB, so I was hopeful that this filter would take care of the interference. Incidentally the Jerrold UMN-3 uhf TV filter is not any less expensive than the 50 ohm unit made by Janel and others and you will not save money taking this approach. I just used it because I happened to have one on hand. I installed this BPF ahead of the Janel low-noise preamp, and every last trace of uplink interference and uhf TV transmitter QRM disappeared. The fantastic sensitivity of the 435.1 MHz downlink system, fortunately, did not disappear! At times Mode J is every bit as good as Mode B used to be before the Fall of ’78, but the consistency is still not always there. But the results are close enough to satisfy me (and I can assure you that I am as particular as anyone else).

Perspective

Why must we be so careful in designing our downlink systems for receiving Mode J? Why does every dB make such a difference? Well, the Mode J beacon runs only 100 mW and the entire transponder has only a 500 mW *average* power output or approximately one watt PEP output. A healthy Mode B on the other hand runs 10W PEP most of the time, which is 10 dB stronger! In addition, we have a unity gain one-quarter wavelength monopole downlink antenna on 435.1 MHz with AMSAT-OSCAR 8 Mode J, instead of the circularly polarized turnstyle antenna with about five dB of gain on AMSAT-OSCAR 7 Mode B. Finally, the Mode J antenna does not seem to be optimally positioned with respect to the satellite Z axis and the Earth. However, the successes of AMSAT-OSCAR 8 Mode J are truly amazing. Almost all of the many satellite systems work perfectly. There are no malfunctioning telemetry channels, no noises or oscillations or other distortion in the passband. The telecommand system works flawlessly and the batteries have proven to be very hardy.

Future Improvements in Mode J Operation

Most amateurs are really never satisfied, at least not for long, with their station performance. We are always looking for ways to make our QSO’s easier and more enjoyable. It appears that a better understanding of the AMSAT-OSCAR 8 Mode J antenna orientation during the course of an orbit would be helpful.

"L-Low There"

The incorporation of a Mode "X" on the Phase IIIB spacecraft allows us to increase the communications passband to about 800 kHz which is as wide as the 15m and 20m shortwave bands combined. This broadband aspect offers many advantages to the satellite communicator, but does have some disadvantages. The two main disadvantages are lack of readily available equipment and the cost of any available equipment. It seems that as the frequency of operation of a piece of amateur radio communications equipment increases so does its price. There is no doubt that when Mode "X" flies, equipment will become available; 23 cm transverters and dish antennas are on the market even at this time.

Since the satellite will appear to move slowly with respect to any particular user most of the time, attended operation will not be too difficult—just go outside and reposition the dish every hour or so. This situation is well and good to the ham who can afford it. What about those who can't? Worse yet, what about attracting newcomers to satellite communications?

At hf, a newcomer can come aboard with QRP equipment and a low gain (dipole) antenna. After a while, that newcomer can add a linear amplifier and beam antennas until a well equipped DX chasing station is the result. The cost of such a station is high, but since it is put together over a period of time, meeting that cost is relatively painless.

In the satellite field, Mode A (2 meters/10 meters) is an ideal communications mode for the newcomer because the vast majority of newcomers will have equipment for at least one of those bands. The hf operator will have 10m equipment, the vhf operator will have 2m equipment. Is there any way then that the advantages of the L transponder can be combined with the advantages of (and need for?) Mode A?

Just because a satellite transponds signals from one frequency to another does not necessarily mean that a user has to have equipment to cover those bands to communicate via that satellite. The satellite contains a linear transponder or repeater. Consider adding a ground based linear transponder or gateway to interface the user to the satellite.

The user will operate Mode A (or any other combination deemed desirable). The gateway will convert these signals to Mode "X".

Communicators will use Mode A at their stations. They will transmit at 145.95 MHz and receive at 29.5 MHz. They will be able to use antennas aimed at the gateway without having to rotate them. Power levels can be set up so that the ubiquitous 10-watt multimode rigs will put good signals into the gateway transponder. The gateway will convert 145.9 MHz signals to 1269

MHz and uplink them to the satellite. The satellite downlink at 435 MHz is converted to 29.5 MHz and transmitted by the gateway at low power levels. One such gateway station could serve the needs of most of a metropolitan area.

The gateway concept would not only allow newcomers in the populated metropolitan areas to join the ranks of the satellite communicators by letting them operate on Mode A, it can also eliminate most of the passband overloading problems experienced on the Phase II satellites by cutting down those signals before they even get uplinked. The same microprocessor that controls the antennas in the gateway station would make sure that excessive uplink power would not be radiated.

The gateway concept would have several disadvantages so after a while the user would feel the need to graduate to a full station and bypass the gateway. First of all, it would be of limited bandwidth. The gateways would be limited to about 100 kHz or so, all gateways using the same segment of the passband, thus communicators using the gateway, although able to use the satellite are missing out on using most of the passband. Secondly, other operating constraints could be put on the gateway stations such as limiting operating hours, awards for QSO's, etc.

Digital communications would also find gateways advantageous. Conventional terrestrial RTTY signals flowing between the user and the gateway would be converted to packet format by the gateway which becomes one node in a digital communications network. It would remember the callsigns of all its local users and receive and hold any messages in the packet network addressed to any of them, for later interrogation. These digital channels could even be on a different band, such as the regular two meter fm RTTY computer repeater would now contain an interface to the gateway—expanding its sphere of operation. A local simplex packet repeater could also interface the gateway directly.

AMSAT could come up with a gateway specification based on the AMSAT-GOLEM-80 microcomputer and the linear transponders Project OSCAR Inc. are operating in the San Francisco Bay area. The technical capability exists at the present time. Local AMSAT groups or other amateur radio clubs could build gateway stations to these specifications and run them according to an operations plan published by AMSAT. The challenge in satellite communications and the cost would be shared. A gateway station should not be more difficult to build than a sophisticated two meter terrestrial repeater.

AMSAT News



Organizational items of interest to all members of the Radio Amateur Satellite Corporation

Ariane/ALINS Success!

It was very good news indeed that originated in the steamy jungle of Kourou, French Guiana, South America recently. It's Early Friday morning, 19 June when the sleek silver rocket painted with the flags and hopes of a European community virtually leaps from the tropic floor to the climateless boundaries of planet Earth. And with its swift ascent, the fortunes of the European Space Agency's Ariane and the dozens of prospective "passengers" for the world's newest heavyweight launcher rose as well. The success this past June was especially gratifying to ESA after a 13 month stand-down because of the disastrous failure of the prior test launch May 23, 1980. On that occasion the LO2 Ariane vehicle ungraciously deposited AMSAT's Phase IIIA satellite and the Firewheel satellite of the Max Planck Institute at fifty fathoms.

The unqualified success of LO3 means, however, ESA is back in the match; the game being the much discussed competition between NASA and ESA for future launch business. AMSAT's spirits were equally buoyed by the LO3 success since it marks a strong comeback from the LO2 debacle. And, while the LO3 success does not guarantee AMSAT a particular launch date for Phase IIIB, it is certain that had LO3 met a fate similar to that of LO2, a 1982 Ariane launch for Phase IIIB would have been virtually out of the question. Furthermore, the ability to resolve the extraordinarily complex problems associated with the combustion instability at the root of the LO2 failure illustrates both the skill and determination of ESA, CNES and SEP.*

The news of the LO3 launch was carried in real-time by ALINS (AMSAT Launch Information Network/Service) to amateurs around the world. The 3-station network comprised WA3NAN, the club station at the Goddard Space Flight Center, Greenbelt, Maryland; W6VIO, the club station at the Jet Propulsion Laboratory, Pasadena, California; WA2LQQ, the station of *ASR* Editor and AMSAT Bulletin Station operator Vern Riportella.

WA3NAN was staffed by AMSAT Operations Vice President K1HTV and his harmonic Andy, KA1GD, and operated on 14.282 MHz covering North America. W6VIO was operated by Jim Lumsden, WA6MYJ and George Morris, W6ABW. The arrangements for use of W6VIO were made by ARRL Southwest Division Director Jay Holladay, W6EJJ. Jay is Chairman of the Amateur Satellite Service Council (ASSC).

W6VIO provided 40 meter coverage to Western North America and 20 meter coverage to Asia/Pacific. The 20 meter link was especially effective providing excellent signals to Japan, Philippines and Okinawa. WA2LQQ covered Europe on 15 meters beginning just after the band opened for the morning. All three stations were linked to the Mission Control Center at Goddard where AMSAT Vice President for Engineering Jan King, W3GEY, held forth. Also on hand at Goddard were ZS1FE, W4PUJ, W6SP. Paralleling the success of Ariane LO3, this ALINS activity was a notable success. Our thanks, on behalf of all those who monitored, to those who made ALINS work so well!—*AMSAT Satellite Report*

**CNES is the French National Space Agency
SEP is the prime contractor for the Viking V
first-stage engines used by Ariane.*

Flash Flash Flash

In a story breaking at press time, a contingent of ARRL Officials made an unprecedented contribution to AMSAT for the Phase III program. Representing the ARRL Foundation, Mr. George DuPont, WA1SVY presented AMSAT President Tom Clark, W3IWI, with a check for \$56,000. Also on hand for the presentation at the AMSAT Laboratory at the Goddard Space Flight Center was ARRL Atlantic Division Vice Director Hugh Turnbull, W3ABC. AMSAT Officials present included Vice Presidents K1HTV and W3GEY, Office Manager Martha Saragovitz, AMSAT Staff Engineer ZS1FE, Gordon Hardman and a surprise, honored guest XE1TU, Dave Liberman, President of AMSAT Mexico. Photos and additional news on this major event will appear in the next *ASR*.—*AMSAT Satellite Report*

MARCO Slates 2K\$ for AMSAT

In a May 7, 1981 letter to AMSAT, Medical Amateur Radio Council (MARCO) Treasurer Dr. Edward R. Briner, WA3TVG, advised that the enclosed check for \$500 represented the second of four donations in that amount. AMSAT gratefully acknowledges the generosity of the Officers and members of MARCO (and concurrently congratulates them on their good judgement!). Thank you ladies and gentlemen of MARCO!—*AMSAT Satellite Report*

Project OSCAR Meeting Slated

The digital group (Southern) of Project OSCAR will host a general meeting August 29, 1981 at 1300 Pacific Daylight Time. The meeting will be held at the Officers Club, Space Division, Los Angeles Air Force Station, El Segundo, California. Since several of the visiting crew from UK will be in town to prepare UoSAT for launch, it is hoped that they will be on hand at the Project OSCAR meeting to get acquainted and answer questions. Visitors are, as usual, cordially invited. For further information and/or directions, please contact John Browning, W6SP, at 213-643-0151, days.

AMSAT-OSCAR 8 Reference Orbit Refinement

Due to a rapid change in the rate of slowing of AMSAT-OSCAR 8's orbital period, the Project OSCAR calendar for the second quarter is showing considerable errors. Please use the following revised EQX data and interpolate as necessary to obtain intermediate values:

15 Aug 81	17556	01:31:57	85.9
1 Sep 81	17793	01:07:29	80.2
15 Sep 81	17988	00:29:03	70.9
1 Oct 81	18212	01:42:58	89.6

Nominees List Told

At press time the list of nominees for the AMSAT Board of Directors had swelled to eight. Vying for the four open seats will be the incumbents: W6SP, VE2VQ, K1HTV and W3GEY. Other nominees include W6CG, W3XO, KL7GRF and W0CY. In addition, there is the possibility that one or more nominees will be originated in Europe, Asia or Africa. Since the mail transit time from these continents had not expired at press time, we cannot say with certainty that there will be no further nominations. Nominating petitions, however, had to be postmarked no later than 30 June 1981 in order to be accepted as valid.

All nominees are required to submit brief biographical data which will be included in the ballot mailing. The mailing of the Official ballots will take place in late July. All current AMSAT members will receive the ballots by first class mail. The ballots will *not* be included in *ORBIT* or *ASR* to avoid any confusion. The ballots are returnable to AMSAT Headquarters, P.O. Box 27, Washington, DC, not later than 17 Oct. 1981.—*AMSAT Satellite Report*

Editors Note: Annual Meeting 17 Oct. 1981.

Life Members

AMSAT gratefully acknowledges donations of \$200 or more from the following new Life Members.

Norman Barton, VE1BZC
A. Squires, VK3YQX
Christian Lingen, SM6OH
Efrain Ramirez Mauriello, YV4CLV
George McCulley, WA6TVD
Yasuo Nakamura, JA2WO
John Blinke, KI8Y
W.R. Cutter, KB7DE
Dunn J. Sibley III, WB5HQV
James Mankin, N8AKU
Daniel Bolander, WB9TYT
Arthur Swanson
David Mann, N4CVX
Merv Hecht, KO6E
Dr. Richard Sherman, N6IK
Alan Field, ZL2TSC
William Graham, WB7PMS
Ken Wendel, W5RPS
Albert McBride, HC5MB
N.J. Orton, ZL1BNG
Kirk Weatherman, AG6T
Pierre C. Remouchamps, ON5RP
Fred Muller, WA6LQL
C. Vernon Anderson, W1SP
James G. Brown, WA9PKL
Stanley Dworak, Jr., WB3FQE
K. Diane Courtney, WB4INM
Itsuki Tanaka, JH8PZW
Coisme Gomez Perez, YV5EAI
Richard Bash, KL7IHP
John R. Klingman, WA7MHH
Leal Kanstein, W6LK
Robert Spitler, K6GQ
Ellis Marshall, W4JK
Kiichi Okuno, JA9LE
George Norton, W4EEE
Jim Vamplew, VE3CRV
Maurizio Rivarola, IW1PED
G.D. Moss, ZL1TTX
Thomas S. Hall, VP9IB
Carl D. Gregory, K8CG
Ralf Hucce, CE6EZ

T-Shirt Limerick Winners Aired

The decision of the judges is in and the winners of AMSAT's "Hams-in-Space" T-shirt limerick contest are:

First Place: KR6B, Brian Tandrow of Simi Valley, California.

Second Place: KO5I, Doug Loughmiller of Paris, Texas.

Third Place: K2ZRO, Kaz Deskur of Endicott, New York.

Honorable mention goes to G3IOR, W3HV and K1WHS.

Brian's winning limerick was:

There once was a ham from L.A.

Who said, "For this shirt I must pay,

Unless I can rhyme

About pigs, one more time...

And help get Phase 3 on its way."

Congratulations to the winners. Your Hams-in-Space T-shirts will be on their way. Thanks to all the participants, and keep thinking T-shirt, Hams-in-Space and Phase III.—AMSAT Satellite Report

UoSAT on Target for Mid-Sep Date

The University of Surrey (England) Amateur Scientific Satellite, UoSAT, is nearing completion and Program Manager Mar-

Frequency Choices for OSCAR Satellites By DJ4ZC

In response to comments regarding the frequency choice for the OSCAR satellites we inform you about the final result.

We tried to take into consideration the large number of comments we received. Unfortunately it turned out to be impossible to take into account the many often diverging interests. The majority of the comments fell into four groups:

1. It was proposed to use the frequency ranges around 432 and 1296 MHz. Unfortunately this choice is not possible because of the decision of WARC 79 to allocate only the frequency ranges of 435 - 438 MHz and 1260 - 1270 MHz to the amateur radio satellite service; and the latter range only for uplink purposes.

In addition, IARU Region 1 bandplanning allows only for the use of 145,8 - 146,0 MHz in the 2m band. We thus had to stick to these sections.

2. Frequency allocation for the L-transponder below 436 MHz—In view of existing equipment such a choice indeed seemed desirable. But given the higher importance of Mode B and other narrow-band projects it seemed most desirable to put these into the section 435 - 436 MHz. Looking at the chart it becomes clear, that there is simply no frequency space left below 436 MHz for the L-transponder. At this point it is important to note that AMSAT presently is building two Phase III spacecraft. If all goes well it should be possible to operate both satellites at the same time and also to interlink them by ground stations. Thus individual frequency ranges must be assigned to each spacecraft.

The uplink and downlink frequency ranges were selected such that the sum of uplink and downlink frequency results in ...,000 MHz. Hopefully this will help to simplify using the transponder.

3. Interference by non-amateur services—Some of the letters addressed this

point. We tried to take these comments into account. In particular the important Mode B Phase IIIB uplink was moved down as much as possible. Worldwide, though, there seems to be a fairly even distribution of anticipated interference over the bands.

A lot of concern was expressed regarding potential radar interference in the 1260 - 1270 MHz range. According to our information radars seem fairly evenly distributed in this section. The problem is probably not serious because our calculation shows that the radar blanker of the L-transponder can prevent interference. The upper end of the band was selected because IARU Region I bandplanning.

4. Potential interference because of existing amateur usage of the satellite bands—Presently there are the following uses:

a) 145,8 - 145,84 MHz:

FM-relay outputs in Region 1.

It is hoped that eventually new allocations for these relays are found by going to a 12,5 kHz channel spacing.

b) 435 - 438 MHz:

Some TV-activity is present in this region. Eventually it is hoped that TV will move entirely to the 1250 MHz band.

c) 1260 - 1270 MHz:

Some TV-activity in the United States exists in this band. AMSAT hopes that the traditional amateur courtesy will result in acceptable solutions. At any rate AMSAT itself can do very little about this problem but hopes that the operators of relays and TV-stations will recognize the importance of the satellite service and take the necessary steps to avoid interference.

AMSAT wishes to express our thanks for the many letters and constructive comments regarding the satellite frequency choice.

tin Sweeting, G3YJO, is quoted as believing that the remaining outstanding items should be resolved and completed in time for a 20 September 81 launch. UoSAT will be launched from Vandenberg AFB, California as the secondary payload aboard a NASA Delta 2310 launcher. The primary payload is the NASA Solar Mesospheric Explorer (SME). UoSAT is expected to have a four to five year operational life in its low polar orbit having an apogee of 530 km (330 miles) which corresponds to a period of 95 minutes. The orbit is expected to be inclined 97.5 degrees. ASR will begin a series of briefs on the various experiments on UoSAT in an upcoming issue. In addition, a major article on the UoSAT Magnetometer Experiment by its designer, Dr. Mario Acunda, LU9HBG/W3, will appear in an upcoming issue of ORBIT Magazine. Stay tuned!

In a related development, preparations are being made to provide ALINS (AMSAT Launch Information Network/Service) coverage of the 20 Sept. launch of UoSAT. AMSAT officials confirmed 20 July that plans are being formulated to provide real-time coverage of the UoSAT launch in a manner similar to that accomplished recently for

the European Space Agency's launch of Ariane LO3 19 June 81. Preliminary estimates are that a three or four station Amateur Radio network will be configured for the launch, these officials added, to provide coverage to as wide an area as possible. Amateurs around the world should be able to monitor the progress of the launch by tuning to one of the net frequencies on the hf bands. ALINS has previously established similar efforts for Ariane LO1 (24 Dec. 79), LO2 (23 May 80) and LO3 (19 June 81). ASR will announce times and frequencies as well as the participating network hf stations as soon as such details are available from AMSAT HQ.—AMSAT Satellite Report

ESA Council Affirms AMSAT Slot

In a telex to AMSAT DL Headquarters in Marburg, West Germany, ESA (European Space Agency) Director General Erik Quistgaard confirmed that AMSAT will obtain its launch in 1982. The co-passenger aboard the Ariane will be ECS-1, the European Communications Satellite which will provide commercial service.—AMSAT Satellite Report

LETTERS

Malawi International Telecommunications Stamps

Dear Editor:

Satellite telecommunication was first introduced to Malawi in December, 1976, when the Malawi Standard 'B' Earth Station came into operation working to the Indian Ocean Intelsat IV Satellite. This link with the satellite provided for high reliability telephone, telex and telegraph international services where previously this had to be routed through neighboring countries. With the much improved service there was a considerable increase in the usage of this service with a growth of 100% being recorded. It became necessary to expand the services by constructing a larger Standard 'A' Earth Station and an International Gateway Exchange. With these expanded facilities, international subscriber dialing for telephone subscribers is being introduced for access to countries where there is appreciable traffic.

A limited number of Minisheets can be obtained from: Peter Strauss, P.O. Box 35461, Northcliff, 2115, Rep. of South Africa at U.S. \$3 incl. postage by air mail. The minisheet is not cancelled. Some First day covers can be obtained as well at U.S. \$3.—*ZR6MI*

Anniversary

Dear Editor:

The stimulating articles written in commemoration of the 20th anniversary of OSCAR 1 induced me to revisit the old notes and paper concerning the two first OSCAR's.

This revision has shown to me a particular behavior of the two spacecraft which escaped my attention at that time:

OSCAR 1 & 2 were very similar in size and weight; their orbits were also similar: apogee 471 km (1) and 391 km (2). Perigee 245 km (1) and 208 km (2). Inclination also was similar.

In spite of these similarities, the life of OSCAR 1 as an orbiting object, lasted twice the OSCAR 2 one.

If my data are correct, the first burnt out in the denser atmosphere during the orbit 627 on 31 Jan. 1962—fifty days after launch. The second instead, burnt out at his 317th orbit, 19 days after the launch.

I doubt that only the lower (of 2) perigee has been the cause of such a considerable difference.

I'd like to know the opinion of some people, as Mr. Soifer: in fact I suppose that the difference in season should have had a prominent influence. Because of the orbit inclination, OSCAR 1 should have traveled its orbits for long times in the winter darkness of the north hemisphere, but because the similar inclination, OSCAR 2 might have found op-

posite conditions. May the enhanced ionisation in the northern hemisphere have exerted a stronger drag on OSCAR 2? Or, were there some more factors that I cannot guess?

Concerning the amateurs involved in these "ancient" experiments, I am pleased to remark the prominent activity of I3BMV (now IV3BMV) Giorgio GIRO - TRIESTE - viale XX Settembre 28 - and his article "Predicting OSCAR's Orbit with Ease" published in the June 1972 issue of *CQ Radio Amateurs Journal*.—*I4SN*

Old Cover Date?

Dear Editor:

Received *ORBIT* today and find it the best one yet in variety of articles and comments.

Would suggest leaving date off front cover as it causes one to think they are receiving "old" news etc., which in fact, the articles were quite current.

Congratulations on an excellent job done.—*W4DWN*

Dear Editor:

If OSCAR 7 and 8 were reliable as the delivery of *ORBIT* Magazine there would be no contacts made. If the magazine can't be gotten out on time it should either change staff so that it could be out on time, or discontinue its printing.—*K7HSX*

Volunteers for the job of Editor are in order—Editor

Japanese Weather Satellite Launch

Dear Editor:

According to recent Japanese newspaper, Japanese Geostationary Weather Satellite, HIMAWARI No. 2 will be launched on August 10, 1981 by using N-II rocket No. 2.

Its weight is about 653 kg. HIMAWARI No. 2 will take the picture of earth's surface at every 30 minutes by using visible light and infrared ray, and will relay weather data from ships, aircrafts and buoys to weather center. (Note: HIMAWARI means sunflower in English)

Other Japanese satellite schedules are as follows:

TT-500A-No. 10 August 1, 1981
MT-135P-T No. 31 August 11, 1981
S-310-No. 10 August 24, 1981
S-520-No. 4 September 4, 1981
S-310-No. 11 September 7, 1981

TT and MT will be launched from Tanegashima Island Space Center by National Space Development Agency. S series will be launched from Kagoshima Space Observatory by Space Science Laboratory.—*JA2WO*

Satellite Log

By Geoffrey Falworth*

Satellite Log features launches into orbit since the beginning of 1980. The satellite name is that assigned by the launching agency (the international designation is in parenthesis) and the orbit (period, inclination to Earth's equator, apogee height, perigee height) is for shortly after launch; later maneuvers may modify this orbit. Transmissions are those which are publicly reported or assumed from the type of spacecraft involved.

Cosmos 1239 (1981-04A) launched on 1981 Jan 16; initial orbit: 89.05 min, 82°.34, 236 km, 215 km; transmissions: none reported. Recoverable reconnaissance satellite.

Cosmos 1240 (1981-05A) launched on 1981 Jan 20; initial orbit: 89.77 min, 64°.88, 357 km, 171 km; transmissions: none reported. Recoverable reconnaissance satellite.

Cosmos 1241 (1981-06A) launched on 1981 Jan 21; initial orbit: 105.02 min, 65°.82, 1007 km, 904 km; transmissions: none reported. Anti-satellite system target spacecraft.

Progress 12 (1981-07A) launched on 1981 Jan 24; initial orbit: 89.24 min, 51°.66, 289 km, 190 km; transmissions: 166.000 MHz, 922.750 MHz. Cargo and supply spacecraft, docked with Salyut 6 on 1981 Jan 26.

Cosmos 1242 (1981-08A) launched on 1981 Jan 27; initial orbit: 97.59 min, 81°.18, 657 km, 627 km; transmissions: none reported. Military weather satellite.

Molniya 81 (1981-09A) launched on 1981 Jan 30; initial orbit: 735.65 min, 62°.83, 40805 km, 430 km; transmissions: 800 to 1000 MHz, 3400 to 4100 MHz. Molniya 1-class communications satellite.

Cosmos 1243 (1981-10A) launched on 1981 Feb 2; initial orbit: 97.85 min, 65°.82, 1016 km, 296 km; transmissions: none reported. Anti-satellite weapon test against Cosmos 1241.

Intercosmos 21 (1981-11A) launched on 1981 Feb 6; initial orbit: 94.53 min, 74°.04, 515 km, 475 km; transmissions: 20.004 MHz, 40.008 MHz. Eastern European Earth resources experiments satellite.

Engineering Test Satellite 4 (1981-12A) launched on 1981 Feb 11; initial orbit: 636.26 min, 28°.60, 36025 km, 248 km; transmissions: 136.112 MHz at 1.2 watts, 1705.000 MHz at 2 watts. Japanese satellite testing on-board components and first N2 booster launch.

Cosmos 1244 (1981-13A) launched on 1981 Feb 12; initial orbit: 104.90 min, 82°.95, 1014 km, 963 km; transmissions: 150.000 MHz. Navigation satellite.

Cosmos 1245 (1981-14A) launched on 1981 Feb 13; initial orbit: 90.28 min, 72°.84, 378 km, 198 km; transmissions: 19.989 MHz. Recoverable reconnaissance satellite.

Cosmos 1246 (1981-15A) launched on 1981 Feb 18; initial orbit: 89.10 min, 64°.88, 266 km, 196 km; transmissions: none reported. Recoverable reconnaissance satellite.

Cosmos 1247 (1981-16A) launched on 1981 Feb 19; initial orbit: 706.76 min, 62°.93, 39202 km, 556 km; transmissions: 2292 MHz. Early warning satellite.

Astro 1 (1981-17A) launched on 1981 Feb 21; initial orbit: 96.64 min, 31°.34, 638 km, 571 km; transmissions: 136.725 MHz, 400.450 MHz, 2280.500 MHz. Japanese solar astronomy satellite.

Comstar 4 (1981-18A) launched on 1981 Feb 22; initial orbit: 1436.07 min, 0°.31, 36430 km, 35149 km; transmissions: 3702 to 3738 MHz, 3742 to 3778 MHz, 3782 to 3818 MHz, 3822 to 3858 MHz, 3862 to 3898 MHz, 3902 to 3938 MHz, 3942 to 3978 MHz, 3947.500 MHz, 3952.500 MHz, 3982 to 4018 MHz, 4022 to 4058 MHz, 4062 to 4098 MHz, 4102 to 4138 MHz, 4142 to 4178 MHz, 19040 MHz, 28560 MHz. Comsat General Corporation domestic communications satellite over longitude 142°.34 West.

Operations 1166 (1981-19A) launched on 1981 Feb 28; initial orbit: 88.86 min, 96°.35, 289 km, 143 km; transmissions: none reported. High resolution film-return reconnaissance satellite.

Cosmos 1248 (1981-20A) launched on 1981 Mar 5; initial orbit: 89.68 min, 67°.15, 345 km, 173 km; transmissions: none reported. Recoverable reconnaissance satellite.

Cosmos 1249 (1981-21A) launched on 1981 Mar 5; initial orbit: 89.66 min, 64°.99, 265 km, 252 km; transmissions: 166 MHz. High-resolution low-altitude reconnaissance and surveillance satellite, possibly nuclear-powered.

Cosmos 1250 (1981-22A) launched on 1981 Mar 6; initial orbit: 114.51 min, 74°.03, 1467 km, 1399 km; transmissions: none reported. Military communications satellite.

Cosmos 1251 (1981-22B) launched on 1981 Mar 6; initial orbit: 114.67 min, 74°.02, 1474 km, 1406 km; transmissions: none reported. Military communications satellite.

Cosmos 1252 (1981-22C) launched on 1981 Mar 6; initial orbit: 114.82 min, 74°.02, 1474 km, 1420 km; transmissions: none reported. Military communications satellite.

Cosmos 1253 (1981-22D) launched on 1981 Mar 6; initial orbit: 114.95 min, 73°.98, 1462 km, 1442 km; transmissions: none reported. Military communications satellite.

Cosmos 1254 (1981-22E) launched on 1981 Mar 6; initial orbit: 115.13 min, 74°.02, 1474 km, 1448 km; transmissions: none reported. Military communications satellite.

Cosmos 1255 (1981-22F) launched on 1981 Mar 6; initial orbit: 115.30 min, 74°.03, 1480 km, 1458 km; transmissions: none reported. Military communications satellite.

Cosmos 1256 (1981-22G) launched on 1981 Mar 6; initial orbit: 115.46 min, 74°.03, 1483 km, 1469 km; transmissions: none reported. Military communications satellite.

Cosmos 1257 (1981-22H) launched on 1981 Mar 6; initial orbit: 115.74 min, 74°.00, 1509 km, 1468 km; transmissions: none reported. Military communications satellite.

Soyuz T4 (1981-23A) launched on 1981 Mar 12; initial orbit: 88.51 min, 51°.61, 222 km, 185 km; transmissions: 20.008 MHz, 121.750 MHz. Manned spacecraft (crew: Vladimir Kovalonok, commander and Viktor Savinykh, flight engineer) docked with Salyut 6 on 1981 Mar 14.

Cosmos 1258 (1981-24A) launched on 1981 Mar 14; initial orbit: 97.99 min, 65°.83, 1024 km, 302 km; transmissions: none reported. Satellite interceptor approached within 8 km of Cosmos 1241 on 1981 Mar 14.

Operations 7350 (1981-25A) launched on 1981 Mar 15; initial orbit: 1436.04 min, 1°.95, 35828 km, 35750 km; transmissions: none reported. Geostationary early warning satellite over longitude 70°.88 West.

Cosmos 1259 (1981-26A) launched on 1981 Mar 17; initial orbit: 90.43 min, 70°.35, 383 km, 208 km; transmissions: none reported. Recoverable reconnaissance satellite.

Raduga 8 (1981-27A) launched on 1981 Mar 18; initial orbit: 1436.14 min, 0°.75, 35800 km, 35782 km; transmissions: 3675 MHz, 3775 MHz, 3875 MHz, 7250 MHz to 7750 MHz. Communications satellite at Statsionar 2 location over longitude 35° East.

Cosmos 1260 (1981-28A) launched on 1981 Mar 20; initial orbit: 93.30 min, 65°.05, 443 km, 431 km; transmissions: none reported. Ocean radar reconnaissance satellite.

Soyuz 39 (1981-29A) launched on 1981 Mar 22; initial orbit: 88.91 min, 51°.78, 249 km, 198 km; transmissions: 20.008 MHz, 121.750 MHz. Manned spacecraft (crew: Vladimir Dzhanibekov, commander and Jugderdemdiyn Gurragcha, researcher-cosmonaut) docked with Salyut 6 on 1981 Mar 28.

Satellite News: The news bulletin of satellites, spacecraft and space activity is available in four editions: *Space Objects Digest*, *Military Space Digest*, *Space Operations Review* and *Space Systems Digest*. The price is 25 cents per issue; subscribe for as many issues as you like. Payments and orders by International Money Order, cash or check. Please add \$2 to personal checks for UK bank charges. Orders should be sent to: Geoffrey Falworth, 12 Barn Croft, Penwortham, Preston PR 10 SX, England.

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We hope that the establishment of this little marketplace will be a help to both these types. So we are going to run our classified section for the next issue or two on a trial basis. If it seems to be paying its way, we keep it. If not, we'll have to investigate another approach.

Please send your submissions (ads) to AMSAT HQ, P.O. Box 27, Washington, DC 20044. Attn: ORBIT Classified. Enclose your check for the amount indicated by the following rate schedule:

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UoSAT Packaged for Trip

(Reprinted from AMSAT Satellite Report)

University of Surrey engineers and technicians spent a few harrowing nights working virtually 'round the clock to isolate and remedy the few remaining "bugs" in the next OSCAR just prior to its shipment to the U.S.A. for launch from Vandenberg AFB, California.

All's well, however, as the last of the malfunctions was cleared from the CCD (charge-coupled device) slow-scan TV camera system during the week prior to shipment. G3YJO, UoSAT Program Manager, Martin Sweeting, and his crew will accompany UoSAT on its trip to the U.S.A.

Meanwhile AMSAT UK has announced additional details on the general operating parameters of the spacecraft.

Propagation Experiment Beacons: 7050, 14002, 21002, 29510 kHz each with an approximate transmitter power of 100 mW.

General Beacon: 145.825 MHz at 350 mW RF power output.

Engineering Beacon: 435.025 MHz at 650 mW power output.

UHF/SHF Beacon Experiment: S Band beacon, 2401.0 MHz at 125 mW output and X Band beacon, 10.470 GHz at 125 mW output. The S-band xmtr uses a 3½ turn helix while the X Band antenna is a slotted 4-turn helix both with LHCP. The HF beacons will take advantage of the 50 foot long gravity-gradient stabilizer boom to provide lower radiation resistance especially on the 40-meter beacon which would be substantially less effective with a physically smaller antenna.

The orbit planned for UoSAT is a sun-synchronous, polar orbit with a nominal altitude of 530 km (330 miles), inclination of 97.5 degrees and period of 95 minutes.

The classic Keplerian elements of the anticipated orbit are:

Semi major axis: 6918.5 km

Inclination: 97.5 degrees

Eccentricity: 0.0015

Argument of Perigee: 62.7 degrees

Right Ascension of Ascending Node: 219.3 degrees

Mean height: 530 km

Telemetry encoding information is now being released by the University of Surrey. The telemetry output can be 1200, 600, 300, 110 or 75 baud ASCII as well as 45.5 baud Baudot, 10 or 20 wpm Morse encoded cw or synthesized voice. The telemetry will be available to either or both the general and engineering beacons in any combination. The modulation scheme is AFSK (NBFM) with a nominal 5 kHz shift. Data encoding for the 1200 baud rate has a 1200 Hz tone denoting logic zero and a 2400 Hz denoting logic one. Thus, since the transmission is phase-synchronous, a 1 comprises two complete cycles (zero crossings) and a 0 is one cycle (zero crossing). At data rates below 1200 baud the data sense is inverted, ie, the 1200 Hz signal corresponds to a 1 and the 2400 Hz signal is a 0.

AMSAT UK and University of Surrey staff will announce the operational status of the UoSAT spacecraft about two weeks after the launch. *ASR* and *ORBIT* will of course QSP details as they become available.

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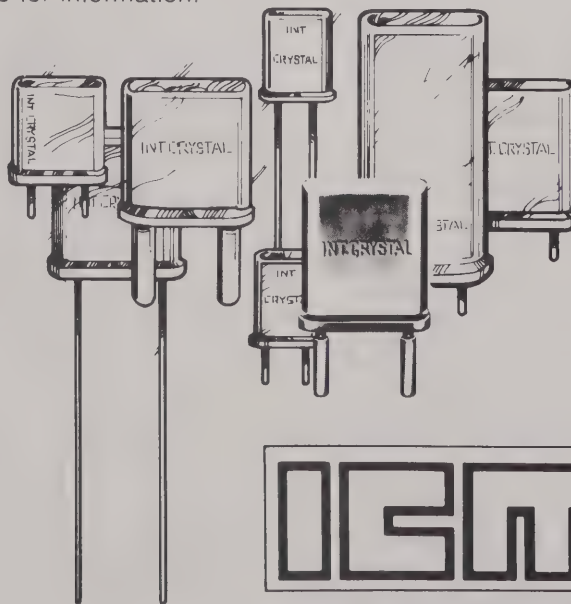
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Around the World



By Kaz J. Deskur, K2ZRO*

A very low noise preamplifier for 432 MHz is described by ZE5JJ (a moon-bouncer par excellence) in March 1980 *RADIO-ZS* (South Africa). The circuit is based on W6PO's design and claims a .47 dB noise figure with an 18 dB gain.

The heart of the circuit is the DEXCELL DXL 3501A GaAsFET transistor that even at 1.3 GHz can provide almost an unbelievable low noise figure of .9 dB. The Hi-Q input circuit is made of a copper strap 1.94" long, .6" wide, spaced .171" above the ground plane. The details of the 4:1 transformer are not given, except that it is a toroid wound on 3/16", very fragile, Q1 material.

The optimum noise figure depends on the value of the drain voltage (3.5-4 V). After the suitable drain voltage has been determined a Zener diode of the same voltage value is substituted. For best results, all decoupling capacitors must be of a feed-through type and the tuning trimmers should be UHF capacitors of the best quality available. The article warns that BNC connectors are not good enough for very low noise circuits (they are noisy due to poor contacts), SMA or at least N type connectors must be employed.

The ZE5JJ 432 Preamplifier

Almost before one has constructed a new pre-amplifier using the most exotic device available, there is another which is better! It is almost impossible to keep up with modern developments in the field of low noise amplification and one begins to believe that efforts to improve a system are obsolete before they are complete. However, in this part of the world, we have to accept what we can obtain and get on with the job.

The low noise pre-amplifier which follows is the result of development by Bob Sutherland W6PO and credit for this work is due to him. My own part of the story is that I constructed one of W6PO's amplifiers, with very minor modifications, and its performance does come up to expectations. The device used is the DEXCEL DXL 3501A GaAsfet which was originally designed as a medium power amplifier and oscillator up to the X-band. It can deliver up to 65 mW of linear R.F. at 8 GHz. It is rugged, has wide bandwidth, high linear gain, consistent performance, no drift and very low distortion. As a low noise amplifier in the 70 cms and 23 cms region it exhibits extremely low values of noise figure, ie at 70 cms the NF is about 0.47 dB and at 23 cms, the NF is about 0.9 dB.

The amplifier is unique in that there is a very high Q input tuned circuit—this is achieved with a strip line situated parallel to the copper plate ground on a piece of P.C. board—the output circuit comprises a 4:1 toroidal stepdown transformer which is untuned. In spite of this the amplifier gain at 70 cms is about 18 dB. Source biasing is prefer-

red because of its simplicity and the drain is supplied from a 12 volt source, through a resistor and zener diode regulator which holds down the drain voltage to about 4.0 volts. This is a critical value set for the particular device and is found by experiment. Its value is that which results in the best noise figure and this can only be found by very careful adjustment.

Construction

A standard Eddystone, or STC die-cast aluminium box is necessary to house the amplifier which is built up on a double sided P.C. board onto which all components are mounted. The original layout called for SMA co-axial connectors—these are however unobtainable here and so standard type "N" amphenol connectors were used. (NB. do NOT use BNC since these introduce noise due to poor connection). My own experience in building UHF amplifiers has confirmed that it is most unwise to use low grade cheap capacitors. A capacitor which introduces bad inductance is most undesirable, particularly when source by-passing is to be employed. Tuning capacitors which are unstable in varying temperatures or are affected by humidity are ill-advised. It is recommended that "ERIE" co-axial bypass capacitors and "JOHANSON" trimmer capacitors be used—I cannot stress this point too strongly. The toroidal transformer employs a 3/16 inch toroid of Q1 material and great care must be exercised when winding on the wire since the toroid is very fragile. The RFC and 100 uF capacitor were fitted to assist in minimising spikes coming in on the +12 volt line, from RF and power line transients.

Adjustment

For this purpose a noise generator is obligatory and preferably a noise figure measuring set up should be available. A G4COM noise computer is invaluable in setting up the amplifier for best noise figure although it will not tell you what the figure is.

Since the circuit is so simple and there are only two trimmers that can be adjusted it does not take long to tune it up somewhere near the optimum value. Having arrived at this point, it is essential to vary the drain voltage from about 3.5 to 4.5 volts to find the point at which the best noise figure is obtained. Having found this point, then solder in a zener which sets up the drain voltage at this optimum value.

It will be found that the best noise figure occurs slightly off the point of maximum amplification. In fact a 1/4-1/2 turn of the input capacitor C2 away from this point of maximum amplification results in the best signal to noise ratio and noise figure.

Results

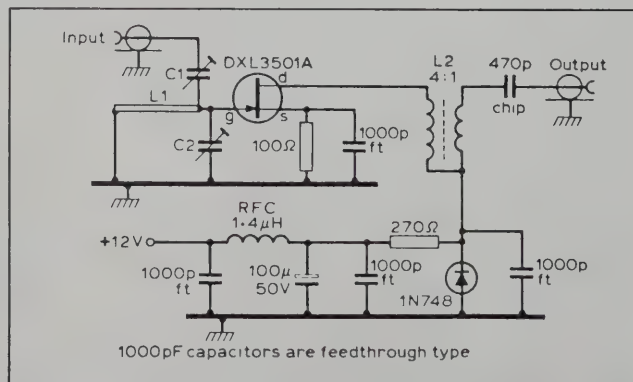
When followed by a second high gain amplifier, it was found that instability occurred. This was cured by inserting a 2 dB attenuator between the first and second amplifiers.

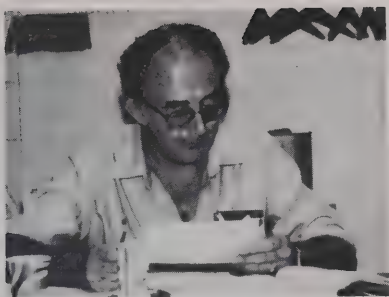
Sun-noise tests, taken about one hour apart and measured very carefully, showed an improvement of 2.5 dB over an NE24406 GaAsfet. Cold sky/50 ohm termination values have risen from about 3 dB to 5 dB indicating a much cooler device.

A test carried out on the distant CYGNUS "A" radio source resulted in a figure of 3.6 dB above cold sky reference, which is 1.4 dB better than ever observed before. Furthermore it was possible to observe that radiation from the radio source was slightly greater in the horizontal plane than in the vertical plane. This is a characteristic of the Cygnus A source which is a non-thermal type whose radiation is of the synchrotron variety—ie it is thought to be nuclear.

Whilst this is academic and of great interest, results on Moonbounce show an improvement of signal to noise ratio. DL9KR was a clear +9 dB above noise and G3WDC +12 dB above noise. Both stations were easier to copy because of the improved signal to noise ratio and noise figure.

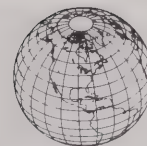
Circuit Diagram





G3IOR

Worldwide Satellite Activity



By Pat Gowen, G3IOR*

AMSAT-OSCAR 7 has not been heard since June 12 except for possible transponder hash. Stations are continuing to monitor hoping for an improvement of some sort.

AMSAT-OSCAR 8 is in excellent health, with lots of activity evidenced on its A Mode, and a steady escalation of new users on Mode J (especially since the demise of AO-7).

Nothing more has been heard of RS-1 or RS-2 in the past two months, but the now completed RS-3 is anxiously awaited, with its 'Robot'. There is the possibility of a high orbit or even an elliptical orbit if launched with one of the USSR's Molniya communications satellites. If the latter is the case, quite large ten meter antennas might soon be in vogue to try to capture the 29 MHz downlink from apogee.

With the sun now decreasing its activity as we pass the peak of the cycle, we can expect that after the October MUF peak, again the high end of the band will provide the majority of communications on ten meters with a good supply of satellites to take it.

Many stations are now set-up for Phase III. Judging by the power of some of the week-end activity on AMSAT-OSCAR 7B, some were testing the effectiveness of their systems already.

In the meantime, it is OSCAR 8 that is serving us with the regular stalwarts still active on most orbits seeking the newcomers.

Bob, G6RH, continues to increase his incredible number of stations worked, but is having great problems in finding just a few more countries plus a few missing QSL's to complete his DXCC-OSCAR. Bob was on Mode B cw only, with only 7 watts, and is now often on Mode J. He has worked forty-

two states, needing only Arkansas and Louisiana in W5, and the remainder in W7, except of course the virtually impossible KH6. Latest DX includes VE8RCS and 5B4AZ both on AMSAT-OSCAR 8A.

PEIBNO, Cees, is another regular who rarely misses an orbit on Mode A ssb. His latest DX QSO's include SU1CR for a new one.

Sam, GM3RFR is now QRV from the most northerly of the Shetland Islands, and was getting a good cw signal into Mode B when it had lost the rest of Europe. He is well situated to give a Europe QSO to large areas of W6 and W7 who may need it to complete their OSCAR-WAC's to join Nick, W0CA, the current sole holder of this coveted award.

Alex, UA1CNA, who was oscarating as UA9JL last year, is another keen regular who rarely misses an orbit on AMSAT-OSCAR 8 Mode A. He has recently worked into eastern USA and made a QSO with WA0LPK/KL7, and is QRV 29.430-445 MHz cw for more DX.

John, GM4IHJ prefers Mode J, but got on AMSAT-OSCAR 7B to work WB7RMB and WA5ZIB, the latter being a 7452 Km (4628 mile) QSO path.

Andy, WA5ZIB, had been very active on 7B to work John, as well as HC1BI, HC1AR, GI8NBW, EI4CL, KH6FMT, LU8MBL, WH6AMX, EI6AS, YV5APF, and G3SHK. He heard G3IOR and W4AUZ in QSO on B, so despite only a 20 second maximum window to England's most easterly city, there is hope that G3IOR can work Texas yet. W5VVR is often heard some 15-50 seconds after uplink loss.

Luciano, TR8BL, is active on all modes, and best DX so far is G3IOR. Luciano is looking hard for a South America QSO, and is QRV all orbits within his range in the evenings.

EP2FM wrote to your scribe requesting information, and a packet of how to get aboard OSCAR has been sent, so it is hoped that Iran may soon be active on the birds.

Regrettably, the Desecheo KP2A DX-pedition were not able to operate OSCAR, but gave your scribe HF DXCC no. 344. It is hoped that a few voyagers over the summer holidays will be able to re-activate some of those rarer QTH's now in great demand by satellite enthusiasts active since the earlier days. G6RH, and many others, would like to get some of those scarce VP2's put on by Herb, KV4FZ on his last trip.

For the 'scarcer' countries, see the Table elsewhere on this page.

AMSAT-UK plans a further 'Satellite Activity Week' from 0001 UTC on 4 October to 2359 UTC on 10 October 1981, encouraging cw, ssb and RTTY QSO's on all the available satellites and modes, with the exception of the Wednesday experiment only UTC day, with a transmitting section, and a separate SWL section. Each station contacted or heard may be claimed once per orbit for one point, and with one point per frame of telemetry (e.g. one frame of AMSAT-OSCAR 8 TLM counts for eight points).

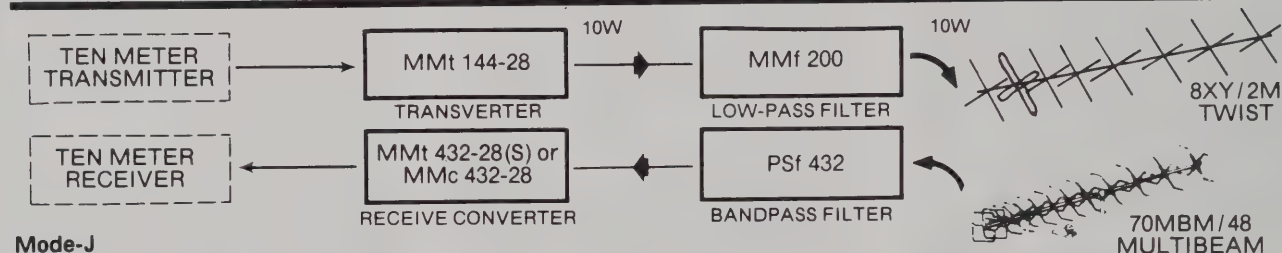
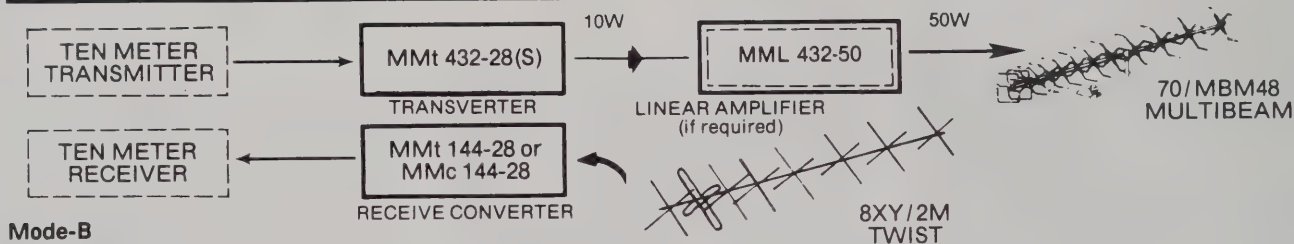
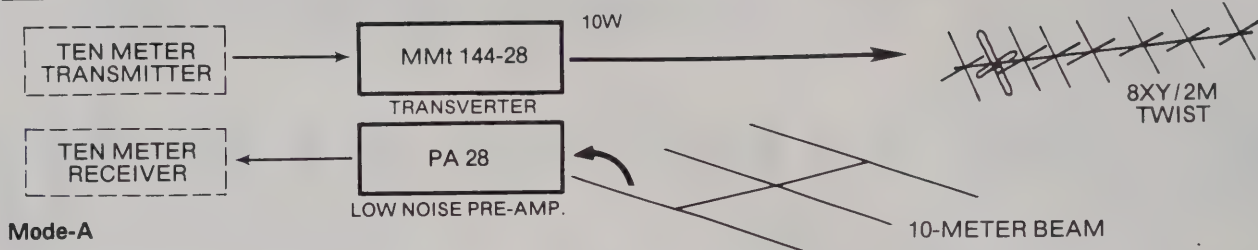
Logs should contain date and time UTC, callsigns, reports exchanged, satellite, orbit number, and mode (A, B, or J). The TLM must be separate, and contain date, orbit number, time UTC in HHMMSS format, and the actual TLM numbers or characters received.

Entries should be accompanied by a cover sheet with the normal station details, section entered, QSO points, TLM points, total, and have a signed declaration of compliance with license conditions, amateur radio spirit, and AMSAT operating recommendations, and sent to G3RWL QTHR, to arrive by 14 November 1981.

Some active DX heard recently.

Station	Mode	Usual Downlink Freq.	Remarks
GJ8KNV	ssb only	145.950-60 MHz	Phil from Jersey, good signal
UA1CNA	cw only	145.935 and 29.435	Active most every pass
G8HWD/M	ssb only	145.950/55	Gordon QRP, QRV for W/VE
IS0MVE	ssb/cw	145.945/55	Good signal from Sardinia
UK4NAA	cw/ssb	145.940	Plenty of UA4 activity now
UL7DD	cw only	145.935/45	On most every orbit
UC2ABN	cw only	145.945	Strongest of all from the area
EA8CR	Mainly cw	435.150	Often active
UW4NI	cw	145.935/45	Also QRV Mode A on AO7 mainly
YO9CN	cw	145.935/45	Also very active on Mode J cw
VE3MJM/VE8		29.440	VE8RCS also on - same station?
HI1RCD	ssb	145.950	Audio rather on the rough side
TR8BL	ssb	145.950/29.450	Active all EQX's 340°-09°W
LX1SI	ssb	145.950	Active again from Luxembourg
UA0ARK	cw	145.940	Zone 18
9H1CE	cw	29.440	New activity from Malta
RA0LFI	cw	145.940/50	Zone 19. Also QRV Mode A cw

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CONVERTERS AND TRANSVERTERS FOR



OSCAR 7 OSCAR 8 PHASE III

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Output Power: 10W.
Receiver N.F.: 3 dB typ.

Receiver Gain: 30 dB typ.
Prime Power: 12 Vdc

Receive Converters

MMc 144 \$59.95
MMc 432-28(s) \$81.50
MMc 432-28(TC) \$79.95

UHF Filters:

MMf 200-5 \$31.95
MMf 200-7 \$42.95
PSf 432 \$59.95

Receive Preamplifier:

PA-28 \$35.95

Mod. kit to adapt original MMt 432-28 FOR Mode-J operation: \$26.50

Transverters by Microwave Modules and other manufacturers can convert your existing low-band rig to operate on the VHF and UHF bands. Models also available for 2M to 70 Cm and for ATV operators from Ch2/Ch3 to 70 Cm. Each transverter contains both a Tx up-converter and an Rx down-converter. Write for details of the largest selection available.

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We've combed the archives for photo images that would convey just that feeling because we know you want to share that spirit with others through your QSL.

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AMSAT may be viewed in many ways. It is often convenient to describe the organization as functioning in three interwoven realms: technical, operational and organizational. By one estimate, 95% of members' activities are within the latter two realms. *ASR* exists, therefore, because of the recognized need to provide timely information to those whose main enterprise in amateur satellites is operating and supporting the organization. To this 95%, then, *ASR* represents a unique conduit to the types of information most valued: current operational and organizational information.

But how does *ASR* relate to *ORBIT*, AMSAT's flagship publication? The *ORBIT* flagship does very well in its treatment of complex or lengthy matters in a concise, paced manner. But since *ORBIT* is a bimonthly, it cannot hope to carry the evanescent. To many interested in staying on top of events (especially those rare DX stations that too often are missed), *ORBIT* is not the solution.

But don't the HF nets carry all the current news? The nets can carry only the most superficial elements of current news. And too often the rigors of propagation and interpretation take a toll in reduced accuracy. So *ASR* clearly supplements the nets with more details and the assured accuracy inherent in a record (written) communication.

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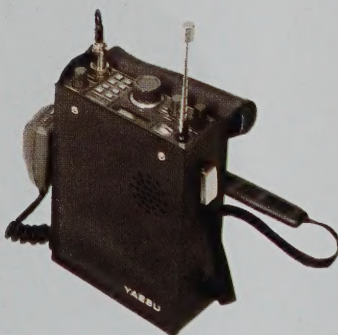


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Some accessories pictured above are extra-cost options. See your Yaesu dealer.

Price And Specifications Subject To Change Without Notice Or Obligation

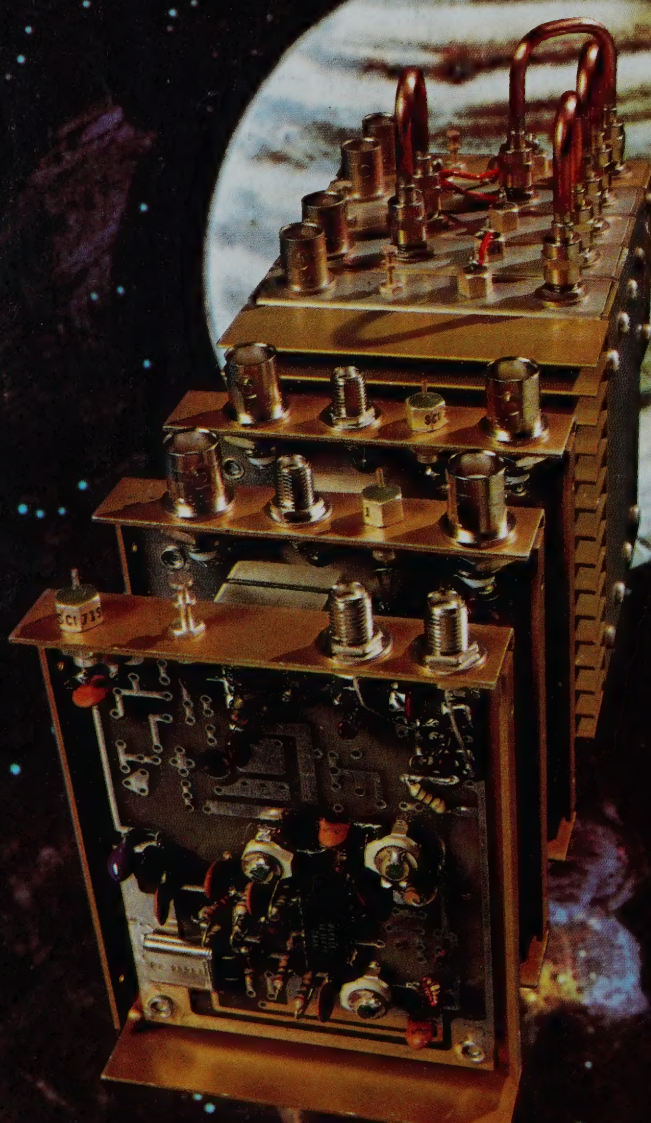
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Our transverter modules are distinctly different from the usual transverter or the home built transverter module. With the single band transverter you must purchase a different unit for each additional band you wish to cover.

Lunar's transverter modules, on the other hand, start with the basic down converter for receive and up converter for transmit. Selecting an appropriate local oscillator module determines the band. Additional modules are added to achieve desired receiving NF and/or output power. Changing the local oscillator module changes the band. Pre amps you already have or might build may be used as desired, similarly, for the transmit side.

It's easier than building your own modules from scratch, and costs much less than buying a complete transverter for each additional band.

Some examples of expected performance using Lunar modules.

EXAMPLE 1

Selected modules:

DC 28
LO 28 144
UC-VHF
PAD 144
PAM 144

This combination gives you:

RF: 144 to 146MHz
IF: 28MHz to 30MHz
Conversion Gain: 25dB
Overall NF: 2 dB nom. 1.6 dB typical
Image Rejection: -30 dB typical
LO Purity: -50 dB max. all spurs & harmonics
Drive 28MHz: 1 to 5 mW
Power Output: 20 watts min.
Operating Voltage: 24VDC @ 2.5 amps. nom.

EXAMPLE 2

Modules added to Ex. 1

LO 28/220/222
PAM 220
PAD 220

This gives you:

RF: 220-222, 222-224MHz
Conversion Gain: 22 dB
Overall NF: 2.5 dB typ., 2.2 nom.
Other specs. remain the same.

If you have a specific band you'd like to cover, write or call us and we'll be happy to discuss it with you. Or send for our literature on transverter modules.



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